1995 Federal Aviation Administration Plan for Research, Engineering and Development

U.S. Department of Transportation
Federal Aviation Administration

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Over the past year, the Federal Aviation Administration (FAA) has taken a critical look inward in an attempt to gain efficiencies by operating as a business. The catalysts behind the FAA's effort to be more businesslike are the rapid changes experienced by the aviation industry and the President's desire to create a more efficient, cost-conscious Government. In this spirit, the 1995 FAA Plan for Research, Engineering and Development (R,E&D) represents an evolutionary step to foster change in the R,E&D program.

The R,E&D Plan describes the FAA's efforts to develop technologies that address both current and projected National Airspace System (NAS) issues so that our Nation can maintain a competitive, robust aviation infrastructure. Two significant changes to the 1995 plan are an effort to focus on long-range planning and a priority-based selection process that ensures only the most important projects are allocated scarce resources and included in the plan. These two changes are key to having an R,E&D program that is innovative in nature, is responsive to our "customers" in every segment of the aviation community, and is more businesslike. However, it is important to remember that this plan and the initial changes instituted are not the final answer.

The R,E&D Plan is not meant to function in a vacuum or as a rigid, inflexible blueprint for the FAA to follow. The R,E&D Plan must be integrated with other FAA plans to create a system development/implementation pipeline and have flexibility to evolve in order to capitalize on new technology opportunities as they arise. Additionally, the FAA will continue to foster a close partnership with the aviation community and look for methods to improve our business practices so that cost-effective solutions to pressing problems in the NAS are developed and implemented faster.

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1.0 OVERVIEW

1.1 Introduction To The Research, Engineering and Development (R,E&D) Program

The Federal Aviation Administration (FAA) manages and operates the National Airspace System (NAS), a significant national resource. However, the demands on this system are continuously growing, and changing technologies provide the opportunity to improve system effectiveness and efficiency. Today, 23 of the country's largest airports are plagued by more than 20,000 hours of delay per year, which is projected to grow to 40 major airports by 2000. Nationally, air traffic delays cost the economy an estimated $6 billion in passenger delays and $3 billion in airline operating costs in 1990. At current trends, these costs will increase 50 percent within 10 years.

Aviation and related industries are also challenged by energy and environmental factors. Currently, 45 percent of air carrier aircraft operating costs are for fuel, a large portion of which is from imported oil. While reducing fuel usage is a priority in terms of energy conservation, it is also an increasingly critical environmental issue, based on recent findings relating to nitrogen oxide emissions at high altitudes. Given the projected increases in aviation activity and stringent environmental standards being proposed in Europe and elsewhere, noise and engine emissions reductions are essential to the national aviation industry's viability.

The FAA must accommodate the increasing demand on limited airport and airspace capacity, deal with crucial airport security issues, and cope with the unforeseen problems of an aging aircraft fleet. These requirements pose unprecedented challenges, which can only be met through a major investment in R,E&D.

The projects in this Plan are those needed to bring the FAA's vision of the future system to reality in the context of a continuing top-level system engineering process. The Plan has enjoyed contributions from across the spectrum of scientific, operational, and user communities. These contributions from both inside and outside Government are solicited and greatly appreciated.

1.2 National Priorities: Quality Results; Quality Delivery

The FAA R,E&D Plan is focused on an ambitious, but attainable, program that spans eight thrust areas and impacts the key national priorities: Economic Health and Productivity; Technological Leadership and Competitiveness; Aviation Safety and Security; Fostering Intermodalism; Energy Conservation; and Environmental Protection. The following narratives describe how the R,E&D Plan is consistent with the Department of Transportation's Strategic Plan goals and how the Plan contributes to the National Priorities.

Strengthening Transportation's Role in Supporting the Economy

There is little doubt of aviation's significance to the U.S. economy. With no additional major airports planned in the near term, the FAA must expand the current system's capacity while maintaining its safety and reducing its inefficiencies.

Research to develop more automated air traffic control (ATC) systems, higher capacity and more reliable communications, improved surveillance, enhanced weather detection and information dissemination, more flexible navigation and landing systems, and improved human/machine interfaces will provide NAS improvements (e.g., reduced delays and increased system capacity), and help maintain economic growth.

Research, necessary to accommodate and integrate new technological developments, will also help create markets for industry. With the increase in international competition, Government and industry must continue to expand and modernize our aviation transportation system rapidly, or the United States will be likely to suffer economic consequences in terms of future risk to jobs and business leadership.

Advancing U.S. Transportation Technology and Expertise

A primary R,E&D Program goal is to introduce technology advancements into the NAS without impeding aviation services or market mechanisms. Such technology advancements include new types of aircraft, avionics, and flight modes. Research is basic to long-term economic competitiveness since it supports developing enabling technologies at precompetitive stages of the R,E&D process.

Aerospace is key to American technological leadership. Most Government and independent organizations compiling "critical technologies" lists have included technologies essential to the aviation industry, such as propulsion technology, advanced materials, simulation, and automated guidance and control. Examples of FAA research activities to accommodate such advances include satellite navigation and communication systems for traffic over oceans or remote areas; more flexible approach control and landing systems; flight profile optimization techniques; and air traffic models and evaluation tools.

Supporting the Safety of our Transportation System

The overall goal in this area is to reduce the probability and mitigate the results of accidents and terrorism. Research relating to engine and aircraft design will improve airworthiness and crashworthiness, plus eliminate engine and propulsion system failures, aircraft fires, and aging aircraft safety concerns. Human factors and aeromedical research projects have been established to assess injury/fatality patterns and to develop measures that reduce the severity of these patterns. Developing the safest, most efficient aircraft systems also will benefit industry by increasing global sales for U.S. products.

Terrorism remains a threat, and attacks on aircraft or airports have always been a means to attract attention. During the Persian Gulf War, scheduled passenger miles on U.S. carriers decreased by over 16 percent internationally and by over 5 percent on domestic flights. To maintain public confidence in the NAS, new security technologies are being developed to meet increasingly sophisticated terrorist threats, while minimizing the disruption to air traffic services. Key initiatives include weapons and explosives detection measures, which are critical given the increased use of lightweight, nonmetallic materials in such devices; aircraft hardening techniques to minimize the impact of criminal activity; and airport design measures to minimize the risk and disruption to passengers, aircraft, and aviation services.

Fostering Intermodalism

Through research areas such as the FAA's Technology Transfer, Joint University, and Small Business Innovation Research programs, information and data gained through the R,E&D effort can be shared with Government agencies and industries involved in other transportation modes. While FAA-sponsored R,E&D programs do not necessarily have direct applications for other modal transportation needs, the technologies developed for specific FAA requirements may have spin-off benefits. For example, airport pavement design theories and data gathered in the research process may benefit future highway construction. A major element in the FAA's pavement research is reducing life-cycle costs by extending pavement life through a more comprehensive design theory and improved construction materials.

FAA R,E&D work in navigation and communication satellites also can have benefits for the automotive, rail, and shipping transportation modes. FAA satellite navigation research will adapt global positioning system (GPS) technology for many aeronautical uses with aircraft precision landing as the most stringent application. Other transportation modes with less stringent requirements may be encouraged to use GPS with confidence or to adapt the FAA's technology for their own needs. For example, the FAA augmentations are being considered for use in Intelligent Transportation Systems. FAA communications research in areas such as data link will dovetail with the navigation effort for potential shipping, truck, and rail industry tracking applications.

Strengthening the Linkage Between Transportation and Environmental Policy

The importance of aviation to the national economy and the projected increases in air travel provide the stimulus to reduce aviation's environmental impact. Key R,E&D areas include reducing engine emissions and aircraft noise.

Research is required to identify new engine designs that reduce emissions and thus counteract the potential impact future standards will have on U.S. manufacturers. The aviation community recommends developing engine/airframe technology that is 4 to 6 decibels quieter than Stage 3 aircraft. Both domestic and international requirements dictate R,E&D for establishing stricter standards that will allow the United States to manufacture engines with reduced emissions and noise while maintaining its world leadership in a competitive market. In addition, developing more cost-effective environmental certification procedures will enhance the aviation industry's economic well-being as well as being fundamental to fulfilling our environmental responsibilities.

Table 1 provides a synopsis of R,E&D programs contained in this Plan, their benefits to users, and the national priorities to which they relate:

Table 1. Impact of R,E&D Programs on National Priorities

Program Area	Feature	User Benefits	Principal National Priorities
Advanced Traffic Management System	Ability to handle increased traffic	Reduce operating costs Reduce flight delays Accommodate requested routes	Strengthening Transportation's Role in Supporting the Economy
Oceanic Air Traffic Automation	Ability to handle increased traffic	Reduce operating costs Reduce flight delays Accommodate requested routes	Strengthening Transportation's Role in Supporting the Economy
Terminal Air Traffic Control Automation	Ability to improve aircraft arrival capacities	Reduce operating costs Reduce flight delays	Strengthening Transportation's Role in Supporting the Economy
Airport Surface Traffic Automation	Ability to prevent runway accidents/incidents	Improve safety on airport surface	Supporting the Safety of Our Transportation System and Strengthening Transportation's Role in Supporting the Economy
Aviation System Capacity Planning	Ability to provide short- and long-term capacity improvements	Reduce impact of projected traffic bottlenecks	Strengthening Transportation's Role in Supporting the Economy
Traffic Alert and Collision Avoidance System	Ability to reduce chance for midair collision	Improve safety in air	Supporting the Safety of Our Transportation System and Advancing U.S. Transportation Technology & Expertise
National Simulation Capability	Ability to validate ideas	Reduce development risk	Advancing U.S. Transportation Technology & Expertise and Strengthening Transportation's Role in Supporting the Economy
	Ability to engage in applied research	Improve human factors	
Aeronautical Data Link	Ability to use data link capability fully	Reduce miscommunication between pilot and controller Reduce congestion in communication links	Supporting the Safety of Our Transportation System and Strengthening Transportation's Role in Supporting the Economy
Airway Facilities Future Technology	Ability to define advanced technology for future operations and management	Reduce operation costs Increase technology injection and improve NAS integrity	Supporting the Safety of Our Transportation System and Advancing U.S. Transportation Technology & Expertise
Satellite Navigation	Ability to use satellites in aircraft navigation	Reduce operating costs Reduce delays	Strengthening Transportation's Role in Supporting the Economy, Advancing U.S. Transportation Technology & Expertise, and Fostering Intermodalism
Terminal Area Surveillance System	Ability to define next generation surveillance sensors	Increase terminal area capacity	Supporting the Safety of Our Transportation System

Table 1. Impact of R,E&D Programs on National Priorities

Program Area	Feature	User Benefits	Principal National Priorities
Weather Detection/ Dissemination	Ability to reduce impact of weather	Reduce delays due to weather	Strengthening Transportation's Role in Supporting the Economy and Supporting the Safety of Our Transportation System
Airport Technology	Ability to improve airport planning and design	Reduce airport and airline operating costs Reduce airport surface accidents	Strengthening Transportation's Role in Supporting the Economy, Supporting the Safety of Our Transportation System, and Fostering Intermodalism
Aircraft Systems Fire Safety	Ability to improve fire detection/suppression	Reduce fire-related injuries and deaths	Supporting the Safety of Our Transportation System and Fostering Intermodalism
Aircraft Crashworthiness	Ability to increase passenger protection from an accident	Reduce crash-related injuries and deaths	Advancing U.S. Transportation Technology & Expertise and Supporting the Safety of Our Transportation System
Propulsion and Fuel Systems	Ability to increase the safety, reliability, and durability of engine installations and fuel systems	Enhance airworthiness Reduce accidents	Advancing U.S. Transportation Technology & Expertise and Supporting the Safety of Our Transportation System
Flight Safety/ Atmospheric Hazards Research	Ability to improve methods for dealing with ice, lightning, and other hazards	Reduce accidents Develop criteria for aircraft design	Advancing U.S. Transportation Technology & Expertise and Supporting the Safety of Our Transportation System
Aging Aircraft	Ability to detect, control, and prevent aircraft structural weaknesses	Reduce accidents Develop criteria for aircraft design	Supporting the Safety of Our Transportation System and Strengthening Transportation's Role in Supporting the Economy
Aircraft Catastrophic Research	Ability to prevent catastrophic aircraft failures	Reduce crash-related injuries and deaths Reduce hull losses	Supporting the Safety of Our Transportation System and Advancing U.S. Transportation Technology & Expertise
Threat Detection	Ability to improve weapons and explosives detection	Eliminate civil aviation as a terrorist target Increase public confidence	Supporting the Safety of Our Transportation System and Advancing U.S. Transportation Technology & Expertise
National Airspace System Security	Ability to evaluate security improvement ideas	Reduce security threats	Supporting the Safety of Our Transportation System
Aircraft Hardening	Ability to reduce damage from explosives	Reduce explosive-related injuries and deaths Reduce hull losses	Supporting the Safety of Our Transportation System and Advancing U.S. Transportation Technology & Expertise

Table 1. Impact of R,E&D Programs on National Priorities

Program Area	Feature	User Benefits	Principal National Priorities
Human Factors	Ability to reduce human errors or inefficiencies	Reduce human-caused accidents, incidents, and inefficiencies	Supporting the Safety of Our Transportation System and Strengthening Transportation's Role in Supporting the Economy
Environment and Energy	Ability to reduce noise and air pollution	Improve air quality	Strengthening the Linkage Between Transportation and the Environmental Policy, and Advancing U.S. Transportation Technology & Expertise
		Reduce aviation noise impacts	
Innovative/Cooperative Research	Ability to develop new ideas jointly	Stimulate market productivity	Advancing U.S. Transportation Technology & Expertise and Strengthening Transportation's Role in Supporting the Economy
		Increase technology injection	

1.3 Goals

Two types of goals are listed in this section: NAS goals supported by the R,E&D Plan and R,E&D-specific goals. NAS goals appear in both the FAA's R,E&D Plan and the Capital Investment Plan because projects that contribute to achieving these goals require both developmental and acquisition efforts. R,E&D-specific goals appear only in the R,E&D Plan, and projects that contribute to these specific goals will generally not require an FAA acquisition effort.

The purpose for the goals is to provide direction for the overall R,E&D program and a desired level of achievement. The FAA will continue to review and track progress toward attaining these goals, but they are only goals, not inflexible specifications that must be met at all costs. A characteristic of research projects is that they may not always come to fruition, which may cause the FAA to fall short of meeting a goal. For instance, research may prove that the technology or concept under consideration does not perform as intended or is not cost beneficial. While the FAA has attempted to develop goals that are measurable and attainable, these goals should not be treated as fixed R,E&D program specifications. The charts in the following section depict the NAS- and R,E&D-specific goals.

NAS Goals Supported by the R,E&D Plan

- Reduce civil aviation fatality rate from all causes by 10 percent by 2000.

From 1984-1993, the fatality rate ranged from a high of 29.4 to a low of 15.1. In 1993, scheduled U.S. carriers experienced only one fatal accident resulting in a single fatality. The potential to achieve a 10 percent reduction from the 1990 level most likely rests with general aviation.

Fatality rates per million of departures (includes all fatalities)

1990	1991	1992	1993
15.1	18.7	20.1	16.3

- Reduce accident and incident rate attributable to weather by 20 percent by 2000.

Accident and incident rates per million of departures

1990	1991	1992	1993
16.9	17.3	18.6	13.0

- Reduce runway incursion rate by 80 percent by 2000.

From 1986-1993, the incursion rate ranged from a high of 36.7 to a low of 16.9. Generally, the number of airports with runway incursions is decreasing. From 1991-1993, one-third of the airports with runway incursions accounted for approximately 60 percent of all incursions.

Incursion rates per million of departures

1990	1991	1992	1993
25.3	21.3	20.2	16.9

- Ensure that system capacity will meet demand.

System capacity can be expressed in terms of capacity shortfall, measured in delays. Delays are caused by a combination of factors, including weather.

Number of Delays Greater Than 15 Minutes

	1990	1991	1992	1993
Total (000's)	393	298	281	276
Due to Weather	53%	66%	65%	72%
Due to Congestion	36%	27%	27%	21%
Due to Other	11%	7%	8%	7%

NAS Goals Supported by the R,E&D Plan (continued)

- Reduce weather-related delays by 15 percent by 2005.

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  Number of Delays Greater Than 15 Minutes

	1990	1991	1992	1993
Total (000's)	393	298	281	276
Due to Weather	53%	66%	65%	72%
Due to Congestion	36%	27%	27%	21%
Due to Other	11%	7%	8%	7%

- Accommodate a projected doubling of oceanic air traffic demand by 2010.

  With the projected growth rate of five percent per year, oceanic traffic is one of the fastest growing areas in air transportation demand.

  Total oceanic traffic volume

1990	1991	1992	1993
840,000	853,000	862,000	907,000

- Provide more user-preferred routes and altitudes to minimize aircraft operating costs.

  Since 1991, the FAA National Route Program (NRP) provided users with a degree of freedom in flying user-preferred routes. A 1994 survey of 10 major airlines1/ showed an increasing number of flights flying user-preferred routes (subject to Air Traffic Control System Command Center coordination) and an increasing number of flights between designated airport pairs. The result of the program is increased savings in fuel and flight time.

	1991	1992	1993
Total Number of Annual Flights By Reporting Airlines	2,400,000	3,800,000	4,400,000
Reported NRP Flights	17,000	71,000	106,000
Reported Savings			
Fuel (gallons)	2,776,000	11,194,000	21,418,000
Flight Time (hours)	1,480	5,470	16,580

1/ Five airlines reported information for 1991, 7 for 1992, and 8 for 1993.

NAS Goals Supported by the R,E&D Plan (continued)

- Field a wide-area differential global positioning system to provide satellite-based navigation for all flight phases down to Category I precision approach minimums by 1998.

  In 1993, nonprecision GPS approaches were approved for approximately 2,500 of the 5,500 public use airports. Having satisfied the original goal for nonprecision approaches, this goal has been updated to include GPS for precision approaches.

R,E&D-Specific Goals

- Reduce costs of pavement expenditure by at least 10 percent by 2010.

  Currently over $2 billion is spent each year in pavement design, rehabilitation, construction, repairs, and maintenance.

- Develop advanced aircraft fire safety and crashworthiness technologies by 2005.

  During the 15-year period from 1975-1990, there have been over 1,200 fatalities in impact-survivable accidents. Forty percent of these fatalities were attributed to fire.

- Develop advanced technologies that increase assurance of aging and in-service aircraft structural integrity and minimize the potential for aircraft catastrophic failure by 2001.

  From 1981-1992, there were 16 accidents and incidents resulting from catastrophic or structural failures involving contemporary and aged aircraft.

- Reduce accident and incident rates attributable to controller, flightcrew, and maintenance crew human error.

  Accident and incident rates per million of departures

1990	1991	1992	1993
63.7	65.3	66.0	49.7

- Anticipate new threats and develop and implement new security philosophies, technologies, and systems that operate effectively with minimal interference to passengers and carriers.

- Reduce the impact of aircraft noise by 80 percent by 2000 through optimal mix of new aircraft certification standards, operational procedures, land use initiatives, and technology. Define and minimize the impact of aircraft emissions by 2010 through optimal mix of new aircraft certification standards, operational procedures, and technology.

  The FAA has entered into joint research programs with the National Aeronautics and Space Administration to investigate technology advances in source noise reduction and combustor designs to reduce engine emissions. By 2000, noise reduction will be achieved by a complete transition to a Stage 3 aircraft fleet.

  Stage 3 Aircraft, Percent of Fleet

1990	1991	1992	1993
45.0	51.8	59.5	62.4

1.4 R,E&D Initiatives and Accomplishments

The table below maps goals to R,E&D initiatives and accomplishments. The R,E&D initiatives column outlines broad program areas undertaken by the FAA in support of the corresponding goal. The accomplishments column depicts some of the recent strides made toward achieving the corresponding goal.

NAS Goals Supported by the R,E&D Plan

Goal	R,E&D Initiatives	Accomplishments
Reduce the civil aviation fatality rate from all causes by 10 percent by 2000	• Two complementary focuses - reduce accident rate - increase survivability of accidents • Specific programs address - safer aircraft flight operations - improved delivery of weather information to pilots and controllers - advanced collision avoidance technology - improved human factors - elimination of catastrophic failures	• Completed traffic alert and collision avoidance system (TCAS) I limited installation program (LIP) • Developed proposed changes to the TCAS I Technical Standard Order • Completed full TCAS II implementation • Completed TCAS II software upgrade to reduce resolution advisories
Reduce accident and incident rate attributable to weather by 20 percent by 2000	• Basic and applied weather research to - improve forecasts - provide real-time warning products - develop airborne sensors - develop an airborne windshear evaluation and certification system	• Demonstrated and validated integrated terminal weather system (ITWS) initial operating capability (IOC) products (microbursts, storm cells, terminal winds) at Memphis and Orlando ATCT's • Field tested winter icing forecasting at Denver Air Route Traffic Control Center • Completed preparations for procurement of prototype humidity sensor • Completed Phase 3 of windshear training applications for 91/135

NAS Goals Supported by the R,E&D Plan

Goal	R,E&D Initiatives	Accomplishments
Reduce runway incursion rate by 80 percent by 2000	• The airport surface traffic automation program includes - surveillance sensor integration - aural and visual controller warnings - electronically controlled airfield lights	• Completed all airport movement area safety system work • Demonstrated low cost airport surface detection equipment at Houston Hobby airport • Validated use of GPS squitter on airport surface, completed GPS squitter standard, and GPS squitter surveillance specification
Ensure that system capacity will meet demand	• Broad R,E&D thrusts include - automated flow management - ATC automation systems and controller aids - improved information and digital communication systems - improved airport pavements - vertical flight in short-haul transportation system	• Traffic management advisor (TMA) capability installed at Denver • Final approach spacing tool (FAST) at Dallas/Ft. Worth, converging runway display aid at various sites/airports • Completed Phase I digital automated terminal information service • Revised terminal instrument procedures (TERPS) for instrument flight rules GPS approaches at selected locations • Developed recommendations for dual and triple parallel runways that have approximately 4,000 feet spacing using the final monitor aid system • Completed flight standards analysis for flight management system guided curved approaches • Converging runway display aid installed at Dulles, Cincinnati, Philadelphia, and Boston • Validated aeronautical telecommunications network (ATN) manual, conducted flight tests for ATN

NAS Goals Supported by the R,E&D Plan

Goal	R,E&D Initiatives	Accomplishments
Reduce weather-related delays by 15 percent by 2005	• Capacity improvements under instrument meteorological conditions - automated flow management - improved information and communication systems • Basic and applied weather research to - improve forecasts - provide real-time warning products - develop airborne sensors	• Demonstrated and validated ITWS IOC products (microbursts, storm cells, terminal winds) at Memphis and Orlando air traffic control towers (ATCT's) • Completed requirement for reactive windshear detection systems on all Part 121 aircraft as of December 1993 • Established certification requirements for forward look airborne windshear detection device
Accommodate a projected doubling of oceanic air traffic demand by 2010 and Provide more user-preferred routes and altitudes to minimize aircraft operating costs	• Develop satellite-based, direct, two-way (voice and data) communication capability • Develop in-flight rerouting capability to optimize routes • Reduce oceanic separation standards while enhancing safety • Develop automatic transmission of aircraft position to ATC via data link • Develop digital communication system • Develop oceanic track display system • Develop oceanic aircraft conflict resolution capability	• Installed and tested 2-way oceanic data link at the FAA Technical Center, leading to IOC at one Oakland sector in April 1995 • Transitioned interim situation display from R,E&D to facilities and equipment (F&E) • Installed interim situation display at Oceanic Development Facility • Published decision on separation standards reduction • Completed FAST field evaluation • Completed TCAS I LIP, completed full TCAS II implementation • Completed planned arrival and departure system demonstration

R,E&D-Specific Goals

Goal	R,E&D Initiatives	Accomplishments
Reduce costs of pavement expenditure by at least 10 percent by 2010	• The pavement initiatives include - pavement design and evaluation - pavement materials and construction - pavement maintenance and repairs	• Completed layered elastic theory development • Completed design specification for national pavement test machine
Develop advanced aircraft fire safety and crashworthiness technologies by 2005	• Aircraft safety and crashworthiness initiatives include - ultra fire resistant aircraft cabin - improved aircraft structures/materials - improved occupant protection and evacuation	• Completed tests on fire-hardening materials and concepts to protect against fuselage fuel fire penetration • Optimized performance capabilities for cabin water spray system • Completed longitudinal crash testing/analysis on fuselage section with conformable auxiliary fuel tank and overhead bins • Completed general aviation engine performance ground testing using unleaded fuels with additives • Completed technology assessment for detecting critical engine component material flaws
Develop advanced technologies that increase assurance of aging and in-service aircraft structural integrity and minimize the potential for aircraft catastrophic failure by 2001	• Aircraft structural technology research addressing - aging aircraft structural design, improved maintenance and inspection, and performance analysis - catastrophic failure prevention relating to aircraft airframes and all aircraft systems	• Completed technology assessment for detecting critical engine component material flaws • Developed minimum and proficiency requirements for inspection work environments and nondestructive inspection equipment designs

R,E&D-Specific Goals

Goal	R,E&D Initiatives	Accomplishments
Reduce accident and incident rates attributable to controller, flightcrew, and maintenance crew human error	• Specific human factors technologies addressing - aircraft flight deck - air traffic control - aircraft maintenance - airway facilities - flight deck/ATC integration	• Developed crew resource management evaluation expert system software • Developed controller memory enhancement training methods and memory aids • Developed data link functions/services and operational protocols for air carrier and general aviation aircraft
Field a wide-area differential global positioning system to provide satellite-based navigation for all flight phases down to Category I precision approach minima by 1998	• Global Navigation Satellite System research program -- national and international	• Completed minimum operational performance standards for GPS-augmented required navigation performance • Implemented GPS supplemental use for oceanic en route, domestic en route, and nonprecision approaches • Completed first helicopter nonprecision GPS instrument approach to a heliport
Anticipate new threats and implement new security philosophies, technologies, and systems that operate effectively with minimal interference to passengers and carriers	• Several interrelated thrust areas include advances in - explosives/weapons detection - NAS security - human factors - aircraft hardening • Cooperative efforts with other U.S. agencies as well as several international working agreements	• Completed airport demonstration for explosives detection system candidate • Completed operational test and evaluation for screener proficiency evaluation and reporting system • Completed explosives testing for final hardened container prototype

R,E&D-Specific Goals

Goal	R,E&D Initiatives	Accomplishments
Reduce the impact of aircraft noise by 80 percent by 2000, through an optimal mix of new aircraft certification standards, operational procedures, land use initiatives, and technology and Define and minimize the impact of aircraft emissions through an optimal mix of new aircraft certification standards, operational procedures, and technology	• The research within this thrust area consists of - aircraft noise reduction and control - aircraft engine emissions reduction and control	• Developed airport air quality assessment tools and procedures • Released improved aviation noise prediction computer tools • Developed GPS-based noise abatement approach profile for helicopters using precision GPS instrument approach

1.5 Planning For The Future Aviation System

The 21st century aviation system will have less noise, fewer fatal accidents, fewer acts of terrorism, and reduced passenger delays. The future system will be planned to accommodate a broad user spectrum that includes single engine general aviation aircraft, business aircraft, helicopters, commercial aircraft, and military aircraft of all types. It will also be able to accommodate new generation designs such as tiltrotor vehicles, supersonic, and possibly even hypersonic aircraft.

The future aviation system must be international in scope. The changes that are taking place around the world and the rapid increases in the demand for aviation services worldwide, all underscore that we cannot operate independently. The future system will be designed by sharing key technologies with other aviation authorities, and system development will be evolutionary. While it is tempting to design on a "clean sheet of paper" and to propose radical changes, the reality is that changes will evolve systematically.

The Secretary of Transportation's comprehensive policy vividly describes the Nation's transportation infrastructure needs. The FAA's Strategic Plan provides the long-term goals and objectives that the agency is working toward. The R,E&D Program will be used to determine which systems and technologies should be pursued to accomplish these goals and objectives. As R,E&D programs near completion, they may begin a transition stage to the Capital Investment Plan (CIP). The CIP provides the framework for investing in the facilities and equipment needed to improve the NAS.

The FAA has documented a description of the future air traffic management system. The description and technical basis for this vision appear in the Administrator's Operational and Strategic Plans. The vision has broad support from the R,E&D Advisory Committee, users, industry, and the international community through the International Civil Aviation Organization.

However, to bring the vision to operational reality in a reasonable time requires a substantive and aggressive R,E&D Program. Among the vision's elements are:

- Satellite communication technology for air/ground communications over oceans and sparsely populated areas.
- Satellite navigation systems for aviation (and all transportation) over oceans, in less developed parts of the world, and in providing high quality approach guidance to any runway end anywhere in the world.
- Air traffic control digital communications, or data link, to increase safety by reducing misunderstood communications, and, most importantly, in connecting aircraft systems with ATC automation systems.
- Airborne collision avoidance systems, in themselves a major safety tool, that are available to create, in the cockpit, a valuable picture of the traffic situation around the aircraft. Working with the ATC system, such capabilities will lay the basis for a system having greater capacity and enhanced safety.
- Flight management systems, increasingly available in modern transport aircraft, that can facilitate major improvements in working with ATC to create optimal flight profiles.
- Air traffic management and control automation technology that will create major improvements in strategic flow management across the country, providing users more direct routes. Automation in terminal airspace will significantly increase capacities while reducing controller workload.
- Better air traffic surveillance systems. Mode S secondary surveillance radar, satellite and terrestrially based automatic dependent surveillance, new surface surveillance tools, and fast-scan radar will revolutionize the ability to track an aircraft's position.
- Better ways to acquire and use weather and environmental data are on the horizon. Major strides have been made in windshear detection, gathering winds aloft data, and severe storm forecasts. Reducing the impact of wake vortices, a detriment to airport capacity, is possible.
- Airway Facilities Operation Control Center to improve operational integrity of all fielded systems.

Additionally, the FAA is pursuing a vision to enhance safety and security for aircraft occupants. Elements include:

- Materials that further protect the fuselage and cabin interior from burnthrough.
- Water spray systems for fire protection inside the cabin.
- In-flight smoke venting systems to discharge smoke and noxious fumes prior to landing.
- Expanding technologies to detect explosives carried by passengers, in baggage, or in cargo.
- Aircraft hardening techniques to better contain explosive forces.
- Improved nondestructive inspection techniques to identify fuselage cracks and corrosion.
- Aircraft design materials and construction techniques to enhance long-term airworthiness, improve crashworthiness, and prevent catastrophic failure from all sources.

2.0 CAPACITY AND AIR TRAFFIC MANAGEMENT TECHNOLOGY

ATC SYSTEM CAPACITY AND AUTOMATION TECHNOLOGY

A major FAA Research, Engineering and Development (R,E&D) aim is to increase air traffic control (ATC) system capacity. Automating the ATC information gathering process is already advanced, but requires major improvement and augmentation in the supporting technologies. The need to help controllers/system managers cope successfully and efficiently with increasing numbers of more demanding and capable aircraft requires introducing automation aids for conducting the ATC process itself. While in the past it was possible to spread the work among a variety of separable functions (oceanic, en route, terminal, tower/airport, etc.), efficient operations now demand carefully integrating and managing aircraft flows throughout the operating regime without artificial "walls."

Increasingly, the air traffic management (ATM) process and its supporting elements must be considered a single system. In the following material, the term "air traffic control" refers to the tactical safety separation service that prevents collisions between aircraft and between aircraft and obstructions. "Traffic flow management" refers to the process that allocates traffic flows to scarce capacity resources. "Air traffic management" is the composite process ensuring safe, efficient, and expeditious aircraft movement. Air traffic control and traffic flow management are components of the air traffic management process.

Further ATM system development must be evolutionary. There is often the temptation to design on a "clean sheet of paper" to take full advantage of new capabilities that new technology offers. The reality is that transition and integration are the most difficult institutional problems facing system designers. However, while change in the system will be evolutionary, the design for the future is intended to provide a well understood, manageable, cost-effective improvement sequence. These improvements will keep pace with user needs for safety, capacity, efficiency, and environmental demands.

DEVELOPMENT CHALLENGES

The FAA R,E&D efforts needed to achieve increased ATM system capacity and to introduce automation technology represent a major effort with many important challenges to the FAA's and the Nation's R,E&D community. Among the many challenges, the following may stand out in importance:

- To develop a system architecture and create a system design that recognizes and accommodates the full ATM system demands as an integrated whole.
- To establish the appropriate balance between the basic ATC separation processes and the overlying flow management/control system.
- To establish the best ways for controllers/system managers to interact with and effectively use automation systems to handle more variables safely and efficiently.
- To achieve the correct balance between strategic planning, tactical execution, and modifying the ATM as near as possible to the

flight environment. This balance will be accomplished by rapid information exchange from all available sources, and by using alternative plans created by rule-based computers.

- To establish the best tactical responsibility balance between participating flightcrews with increasingly capable aircraft systems and the centralized ATM system.

- To achieve basic increases in airport capacity and en route/transition sector capacity.

- To create a digital communications system architecture that permits implementing a variety of data link services (space, terrestrial, airport surface, administrative) without requiring multiple data links or excessive overhead communication burdens.

- To create a new level of safety and operational efficiency by developing a full-time airport surface traffic management system.

- To create an ATM system for oceanic areas and remote land areas that emulates United States domestic airspace standards by using new surveillance, navigation, and communications technologies.

- To use environmental information from participating aircraft in operating the ATM system.

2.1 Capacity and ATM Technology Project Descriptions

021–110 Advanced Traffic Management System (ATMS)/Operational Traffic Flow Planning (OTFP)

Purpose: The ATMS/OTFP project produces near-term improvements and long-term enhancements to traffic flow management (TFM) capabilities for the Air Traffic Control System Command Center (ATCSCC) and traffic management units (TMU's) located at en route and terminal facilities. The project will develop automated capabilities to enhance and better manage system capacity resources and eliminate unnecessary flow restrictions. The result will reduce operating costs and flight delays through a more efficient and effective national flow management process.

Approach: To better leverage complementary technologies, the Operational Traffic Flow Planning Project merged with the Advanced Traffic Management System project. The products from OTFP are geared toward the ATCSCC, while products from ATMS are for TMU's. The ATCSCC and TMU's jointly perform the traffic flow management function for the FAA. This common operational goal between the TMU's and ATCSCC suggested that a common research program would provide greater benefits than two separate research programs. This project will focus on developing real-time decisionmaking and analytical support tools for traffic flow management specialists and developing collaborative decisionmaking capabilities aimed at enhancing industry involvement in the traffic flow management decisionmaking process.

The development approach for the decisionmaking and analytical support tool relies heavily on rapid prototyping methods, advanced operations research techniques, and computer modeling. This area addresses three major interrelated research initiatives: real-time flow management decision support tools, TFM operations analysis and performance assessment, and TFM data base management.

The approach for developing collaborative decisionmaking capabilities utilizes extensive analyses of alternative operational concepts proposed by operators, users, and analysts. The project initiatives include FAA/industry data sharing capabilities, enhanced TFM policies and procedures, and interactive decisionmaking.

A unique programmatic aspect of the ATMS/OTFP project is that air traffic management and National Airspace System (NAS) users are an integral part of the project development team. Due to the unique nature of the project, this approach enhances the operational utility of the products, ensures NAS user acceptance, and speeds operational implementation.

For concepts and techniques that potentially have a high operational benefit, evaluations and functional developments/refinements are accomplished in the ATMS/OTFP lab by research and operational personnel. During functional refinement, the research products are structured to facilitate incorporating them into the operational system through the appropriate Capital Investment Plan projects. The ATMS/OTFP project routinely works with NAS users to ensure smooth and equitable operational applications and generate new ideas for products.

Related Projects: 021–140 Oceanic Air Traffic Automation, 021–180 Terminal ATC Automation (TATCA), 021–190 Airport Surface Traffic Automation (ASTA), and 025–130 Air Traffic Models and Evaluation Tools. Capital Investment Plan projects: 21–06 Traffic Management System (TMS), 41–06 Traffic Management

Systems (TMS) Sustainment, 43–21 Operational Database Management System (ODMS), 61–22 ATC Applications of Automatic Dependent Surveillance (ADS), 61–23 Oceanic Automation Program (OAP), and 62–20 Terminal ATC Automation (TATCA).

Products:

Real-Time Flow Management Capabilities

- Strategy Generation Tools
  - Automated Demand Resolution (ADR) Function
  - Ground Delay Manager (GDM)
  - High Altitude Route System (HARS)
  - Knowledge Based Flow Planning Tool (SMARTFLO)
  - Optimized Flow Planning Tool (OPTIFLOW)
- Strategy Evaluation (SE) Tools
  - Strategy Evaluation Function
  - Daily Flow Simulation Model (FLOWSIM)
- Special Use Airspace Management Tools

TFM Operations Analysis and Performance Assessment

- Flight Schedule Monitor (FSM)
- NAS Simulation (NASSIM)

Access to Critical TFM Data Through Data Base Management

- Conterminous United States Data Access Tool (CONDAT)
- Daily Demand Analysis System (DDAS)

1995 Accomplishments:

- Transition ADR-Reroute function to facilities and equipment (F&E).
- Transition ADR-Multiple Airport Scheduler function to F&E.
- Transition GDM function to F&E.
- Conduct FLOWSIM operational test and evaluation.
- Deliver HARS to the Air Traffic Control System Command Center.
- Deliver DDAS to the ATCSCC.
- Conduct OPTIFLOW operational test and evaluation.

Planned Activities:

Real-Time Flow Management Capabilities

The remaining ADR functions that incorporate en route congestion, airport dynamics, weather conditions, and military airspace usage will be developed through 1996. Facilities and Equipment transition will begin in 1996 and be completed in 1998. The ADR function will provide incremental enhancements to generate real-time, system level, alternative national flow management strategies that reflect demand, weather, and special use airspace conditions.

Dynamic special use airspace automation algorithm development will continue with migration to the E-string beginning in 1996. The dynamic special use airspace function will automate and coordinate military special use airspace with the FAA flow management system. The dynamic special use airspace function will be evaluated and refined for planned transition to the enhanced traffic management system (ETMS) in 1997.

In 1996, the SE function will migrate to the operational system. F&E transition will begin in 1996 with projected completion in 1997. The SE function will provide the capability to compute real-time operational impact analysis on alternative national flow management strategies.

The OPTIFLOW initial prototype testbed demonstration and ATCSCC evaluation will continue in 1996. OPTIFLOW field prototype development will follow with field prototype demonstration and evaluation planned for late 1996 and early 1997. OPTIFLOW field prototype delivery is planned for 1997.

TFM Operations Analysis and Performance Assessment

In 1996, NASSIM field prototype development will continue with demonstration/evaluation scheduled to begin in 1997. Field prototype delivery to ATCSCC and TMU's is planned for late 1997. NASSIM will be used to predict and simulate detailed daily traffic and flow strategies utilizing many technologies and tools developed in preceding projects such as HARS, FLOWSIM, and OPTIFLOW.

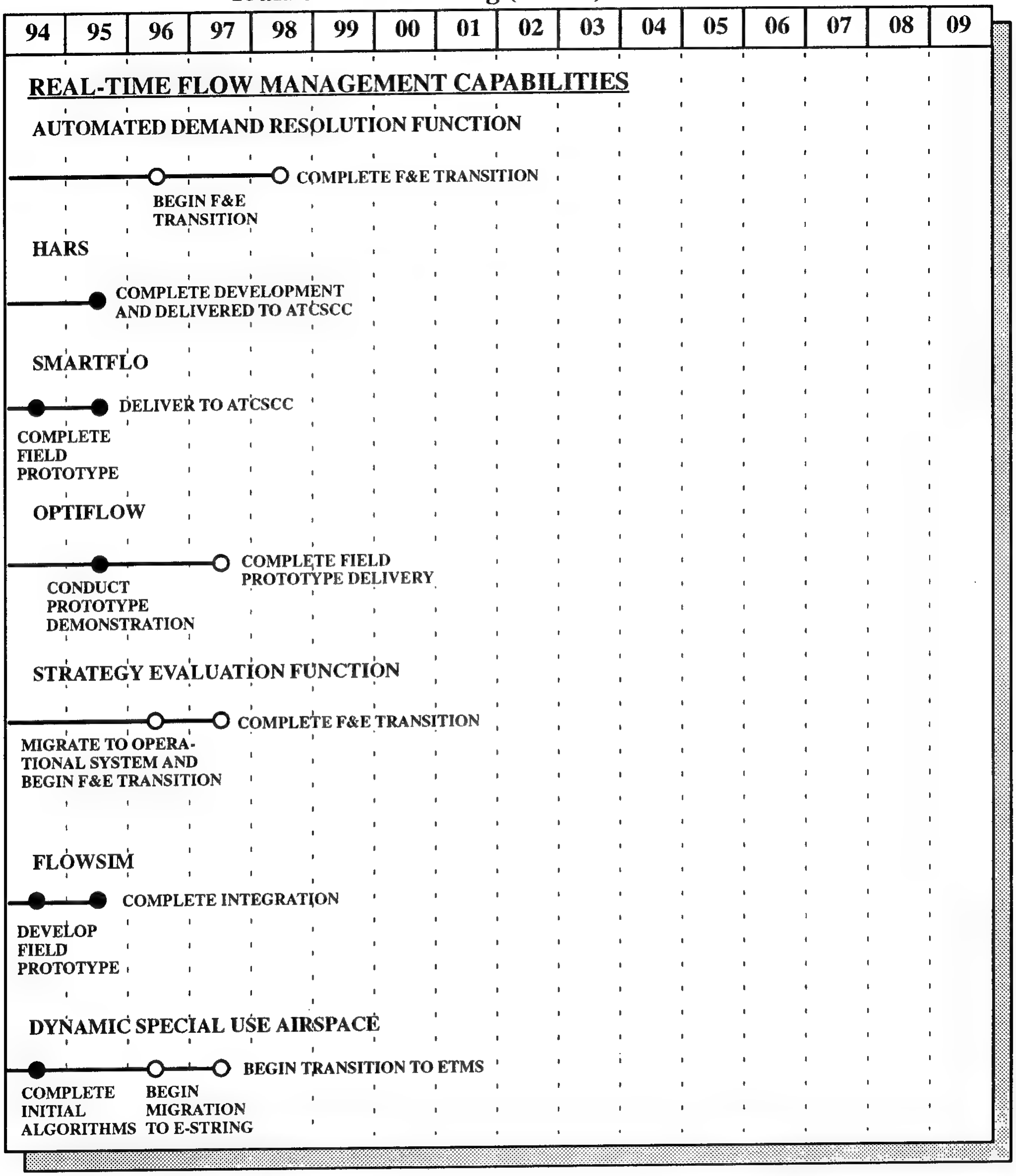
In 1996, the ground delay program substitution visualizer prototype will undergo analysis and integration into the ATCSCC. The final product will be refined and renamed the flight schedule monitor. FSM will be implemented in the ATCSCC in 1997.

Access to Critical TFM Data Through Data Base Management

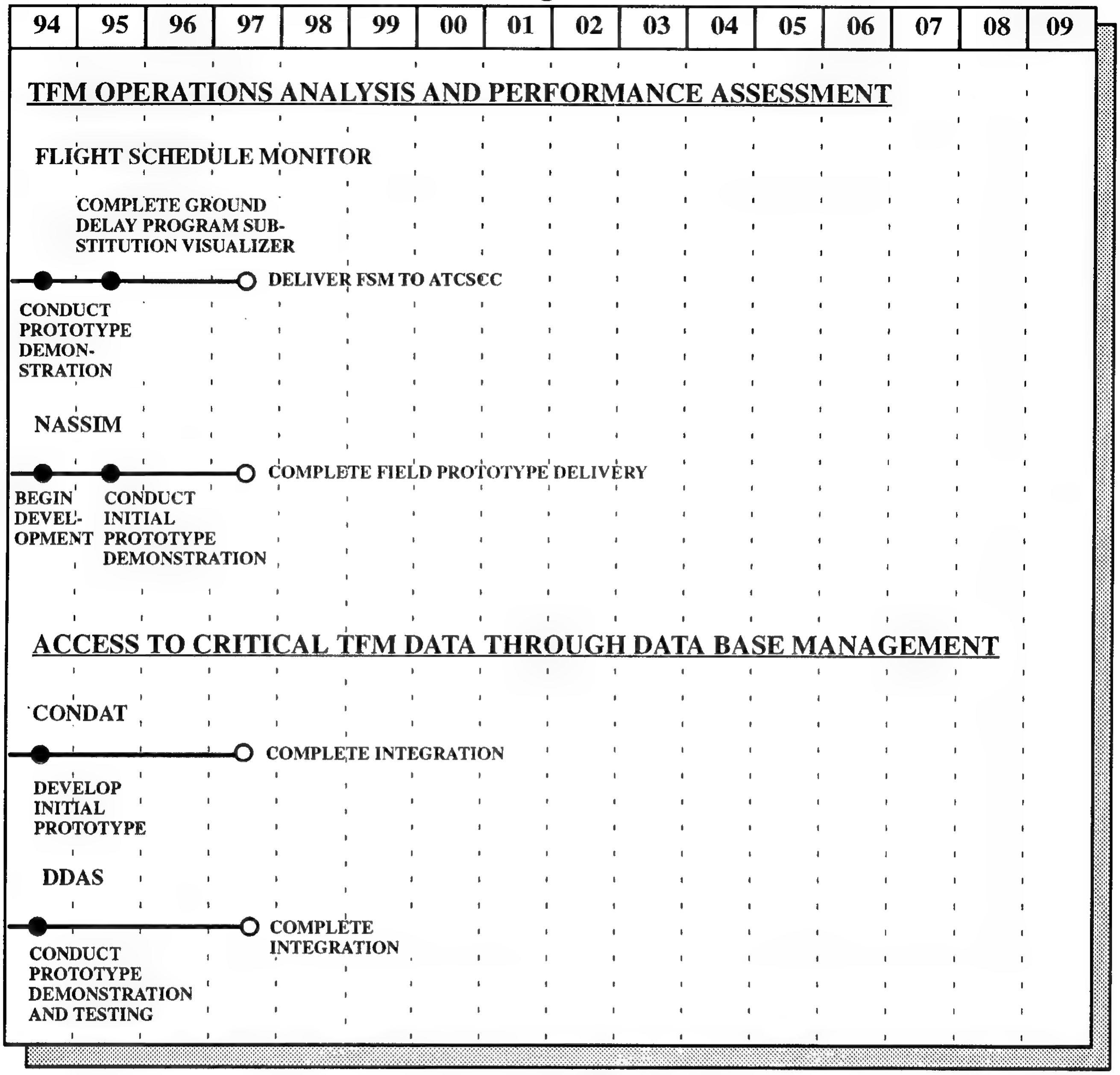
In 1996, CONDAT prototype testing will be completed and final CONDAT development/integration will be completed in 1997.

In 1996, DDAS will continue testbed prototype development of tools for dynamic, digital data exchange of scheduling information between the ATCSCC and airlines scheduling facilities. DDAS integration with other OTFP projects will follow in 1996–1997.

Project 021–110: Advanced Traffic Management System (ATMS)/Operational Traffic Flow Planning (OTFP)



Project 021–110: Advanced Traffic Management System (ATMS)/Operational Traffic Flow Planning (OTFP) (cont.)



021–140 Oceanic Air Traffic Automation

Purpose: The current oceanic system is different from the rest of the domestic NAS and has some inherent limitations. The oceanic environment has no radar coverage, and navigation is handled using only aircraft onboard systems. Air traffic operations are performed manually or with limited automation. Also, air/ground communications are through a third party via high frequency radios that are subject to a variety of atmospheric anomalies as well as human error.

Consequently, there is a requirement for large separation standards that limit user-preferred route flexibility and efficiency. Without improvements, oceanic airspace will be unable to support continued air traffic growth.

This project is aimed directly at enhancing capabilities to increase oceanic air traffic capacity and efficiency without degradation to safety.

Approach: Research efforts will focus on five areas: standards/requirements; studies and analyses; traffic management; air traffic control; and comprehensive, full-system simulation testing capabilities.

Standards/Requirements

The FAA must adhere to International Civil Aviation Organization (ICAO) standards for the airspace delegated to the United States. The Oceanic Research and Development Project Office will participate on international committees to coordinate agreement for global standards and requirements.

Studies and Analyses

The studies and analyses program will identify new air traffic control procedures and automation necessary to increase the airspace users' operating efficiency. The studies address three major areas: airspace utilization, system development, and advanced functions. The primary objective is to formulate methodologies for developing the advanced oceanic automation system (AOAS).

The flight progress strip study will identify means to reduce dependence on flight strips for recording pertinent information and decisions. The study on nowcasting of volcanic hazards and upper winds will focus on providing real-time wind data and warnings of hazards based on satellite data supplied by the National Aeronautics and Space Administration (NASA). These capabilities will be evaluated for applicability to AOAS. Specific methodologies to develop and verify advanced conflict probe and enhanced situation display capabilities will be conducted. Other efforts include a computer/human interface (CHI) study on the graphical representation of flight data and situation display behavior. These activities will be integrated to drive tradeoff analyses for reducing oceanic separation standards through automated systems.

Studies for future oceanic requirements will include: satellite voice communications, 4-dimensional clearance generation, satellite-based surveillance methods for monitoring aircraft separation, and improved strategic traffic management capabilities. The primary method for communicating in the future oceanic environment will be data transmission via satellite. The satellite voice communications study will determine requirements for an emergency satellite voice transmission capability for contingencies such as data transmission failure. The 4-dimensional clearance generation study will determine requirements for automatically generating oceanic ATC clearances and transmitting them via data link. Part of the research emphasis will be to involve the pilot more closely in the air traffic control system when negotiating clearances or requesting changes. The studies on satellite-based surveillance methods for monitoring aircraft separation will focus on having aircraft maintain their own separation independent of ground-based control. The studies will identify requirements and procedures for satellite-based independent surveillance separation assurance methods. The improved strategic traffic management capabilities study will investigate allowing the controller to act as an "intervention specialist" who will exert control by exception only. The controllers will be focusing most of their attention on strategic traffic flow management rather than on tactical traffic control.

Traffic Management

The traffic management effort will provide oceanic traffic managers with automated information gathering techniques and route

development/analysis tools to provide better fuel economies and time efficiencies to oceanic airspace users. A major effort for this project is developing the oceanic traffic planning system (OTPS) which provides functions to enhance traffic management and traffic flow planning. OTPS will generate flexible tracks to take advantage of favorable wind conditions; provide traffic managers with a traffic display system that graphically displays aircraft positions; and a track advisory function that interactively provides airlines gateway loading information prior to gateway entry for improved traffic distribution. Implementing OTPS will result in decreased congestion on tracks, reduced ground delays for air carriers, and reduced workload for controllers. Also, capabilities will be developed for automatically transferring traffic management information between international ATC facilities and airline operation centers. To provide near-term improvements in oceanic operations, traffic management and planning functions will be implemented at appropriate air route traffic control centers (ARTCC's) before they are integrated with the domestic traffic management system.

Air Traffic Control

Air traffic control is based on four core elements: automation, communications, navigation, and surveillance. This area concentrates on the communications and surveillance core elements. Project efforts are focused on developing ground-based systems utilizing ADS technology and satellite communication links. Specifically, development efforts will upgrade oceanic display and planning system (ODAPS) technology with new displays and controller input/output devices. Oceanic data link (ODL) will provide a capability for controllers to communicate with pilots using data link via communication satellites. Added capabilities in the near term will include electronic ATC clearance delivery to aircraft. Future capabilities will include enhanced conflict detection and graphical flight data representation.

Testing

Standards, requirements, and procedures will be tested to validate system performance and capabilities prior to a production decision. Interfaces will be tested to ensure new automation can be integrated into the overall Oceanic Automation System.

An initial testing capability exists at the Oceanic Development Facility (ODF). This capability will be enhanced to conduct the full-range testing needed to complete this project. The facility will provide the capability to conduct end-to-end testing utilizing real satellites, real ground/earth stations, and aircraft cockpits to identify total system performance and to highlight areas needing improvements.

Operational/engineering trials will be conducted with other civil aviation authorities to validate global compatibility of new automation systems.

Related Projects: 021–110 Advanced Traffic Management System (ATMS)/Operational Traffic Flow Planning (OTFP), 031–110 Aeronautical Data Link Communications and Applications, 031–120 Satellite Communications, and 032–110 Satellite Navigation Program. Capital Investment Plan projects: 21–05 Oceanic Display and Planning System (ODAPS) and 21–12 Advanced Automation System (AAS).

Products:

- Telecommunications processor for flight data input/output hardware replacement and software emulation
- Oceanic data link capability that includes ground-to-ground and ground-to-air data communications
- Oceanic controller situation display

- Oceanic traffic planning and management functionality into domestic traffic management system (TMS)

- Air Traffic Service interfacility data communications to facilitate automated data interchange/transfer to and from foreign flight information regions

- Oceanic airspace coordination functions

- Two-way communications between aircrews and oceanic controllers

- Enhanced conflict detection capability

- Next generation flight data processor

- Dynamic aircraft route planning capability

- Track advisory capability for Anchorage, Oakland, and New York Oceanic Centers

- Volcanic hazards forecast model for predicting concentrations of volcanic debris in the atmosphere

1995 Accomplishments:

- Implement two-way data link communications between pilots and controllers including completed ground/ground data communications functions.

- Complete Atlantic and Pacific engineering trials on oceanic data link.

- Complete the Oceanic Development Facility with full end-to-end simulation capability.

- Implement multisector operations with the prototype oceanic data link in the Oakland flight information region.

- Install new OTPS hardware based on UNIX open system platform at all three Oceanic ARTCC's.

- Incorporate dynamic aircraft route planning (DARP) capability in the track generation function.

Planned Activities:

<u>Standards/Requirements</u>

In 1996 and beyond, efforts will continue toward coordinating industry standards for avionics characteristics and minimum operational performance standards. This coordination will ensure that standards and procedures are in place to use the advanced technology being developed for the advanced oceanic automation system. The standards/requirements area allows research, coordination, and agency participation in ongoing forums such as International Civil Aviation Organization, Radio Technical Commission for Aeronautics (RTCA), and National Air Traffic Controllers Association sponsored events.

<u>Studies and Analyses</u>

In 1996, the flight progress strip study will be completed, followed by the CHI study on graphical representation of flight data in 1997.

In 1998, a study will be completed on the utility of using voice over a satellite communications link for air traffic control. This study will be used to determine requirements for a satellite voice communication system. By 2000, an automatic 4-dimensional clearance generation study will be completed to determine requirements for automatically generating oceanic ATC clearances and transmitting the clearances via data link.

From 2000 to 2009, additional studies will be conducted for advanced oceanic functions. In 2005, a study will be completed on satellite-based surveillance methods for monitoring aircraft separation. By 2009, a study will be completed on strategic traffic management functions for a future oceanic traffic system to meet anticipated traffic requirements.

Traffic Management

In 1996, work will begin on centralizing oceanic traffic management at the ATCSCC. The initial goal will be to provide the ATCSCC with full OTPS functionality for the Pacific by early 1997.

In 1997, this project will develop the flight plan processing function and expand the DARP concept to incorporate foreign traffic management systems. Testing will continue through 1998 to integrate the system with foreign systems and create an international traffic management/planning system. At the completion of this phase, the OTPS track generation and traffic display functions will be fully integrated into the domestic traffic management system.

Air Traffic Control

In 1996, an automatic dependent surveillance waypoint position and event reporting capability will be added to the oceanic data link system, and the last ODL installations will be completed at Anchorage and New York Oceanic Centers. In 1997–1998, an aeronautical telecommunications network (ATN) interface will be developed for insertion into the oceanic data link system. A flight data processor replacement prototype will be developed in 1996 and installed in 1997 at the ODF for developmental and operational evaluation. In late 1997, the flight data processor replacement will be installed at Anchorage Oceanic Center for field operational evaluation with expected F&E handoff in 1998. This program will provide flight data processor replacement transition support through 1999.

Two important elements of the Advanced Oceanic Automation System are an enhanced situation display and an enhanced conflict probe capability. In 1997, development for these capabilities will be completed with F&E handoff projected for 1998. This effort will end in 1999 when transition support is completed.

In 1997, the results from the electronic flight data study will be used to begin developing a prototype that graphically displays flight data at the controller workstations. The prototype will be installed at the ODF for operational evaluation in 1998 with field implementation scheduled for 1999. Product transition support will terminate in 2000.

In 1998, the studies on ADS/radar data integration will be used to define interface requirements for the ADS functionality and long range radar systems. This interface will integrate the surveillance sensors to display a coherent presentation on the controller's console. In 1999, ODF simulations and field evaluations will be completed with transition to F&E expected in 2000. This effort will terminate in 2001 when transition support is completed.

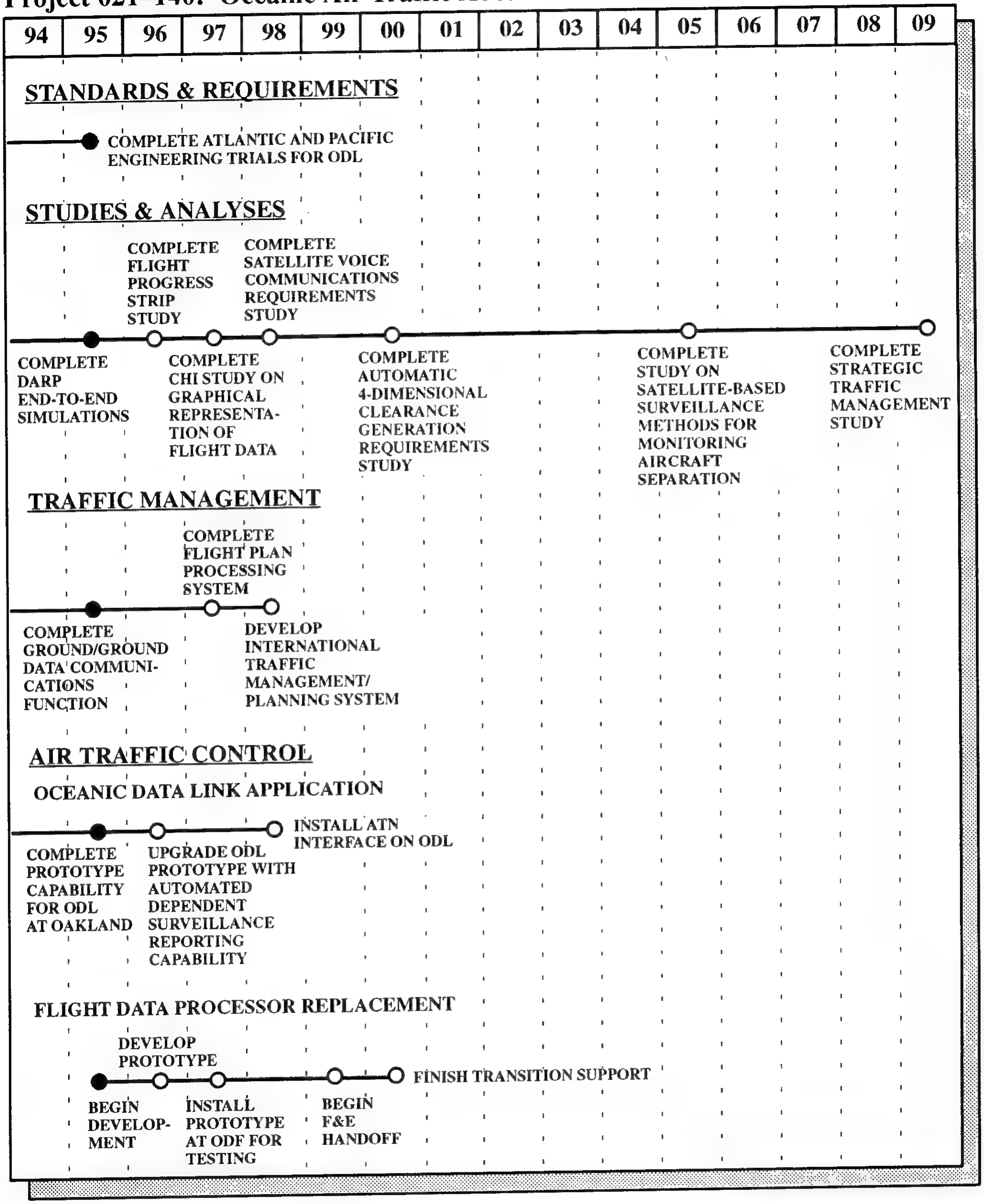
From 1999 to 2000, requirements defined in the satellite communications study will be used to develop interfaces, processes, procedures, and equipment certification guidance for direct two-way voice communications between controllers and pilots via satellite. Development and implementation testing on this capability will take place from 2001 through 2002, with F&E transition in 2003. Transition support is expected to continue through 2005.

In 2001, the automatic 4-dimensional clearance generation study will move to the development stage. Procedures and capability development/implementation testing will be conducted in 2003–2004. F&E transition is expected in 2005, with program support ending in 2007.

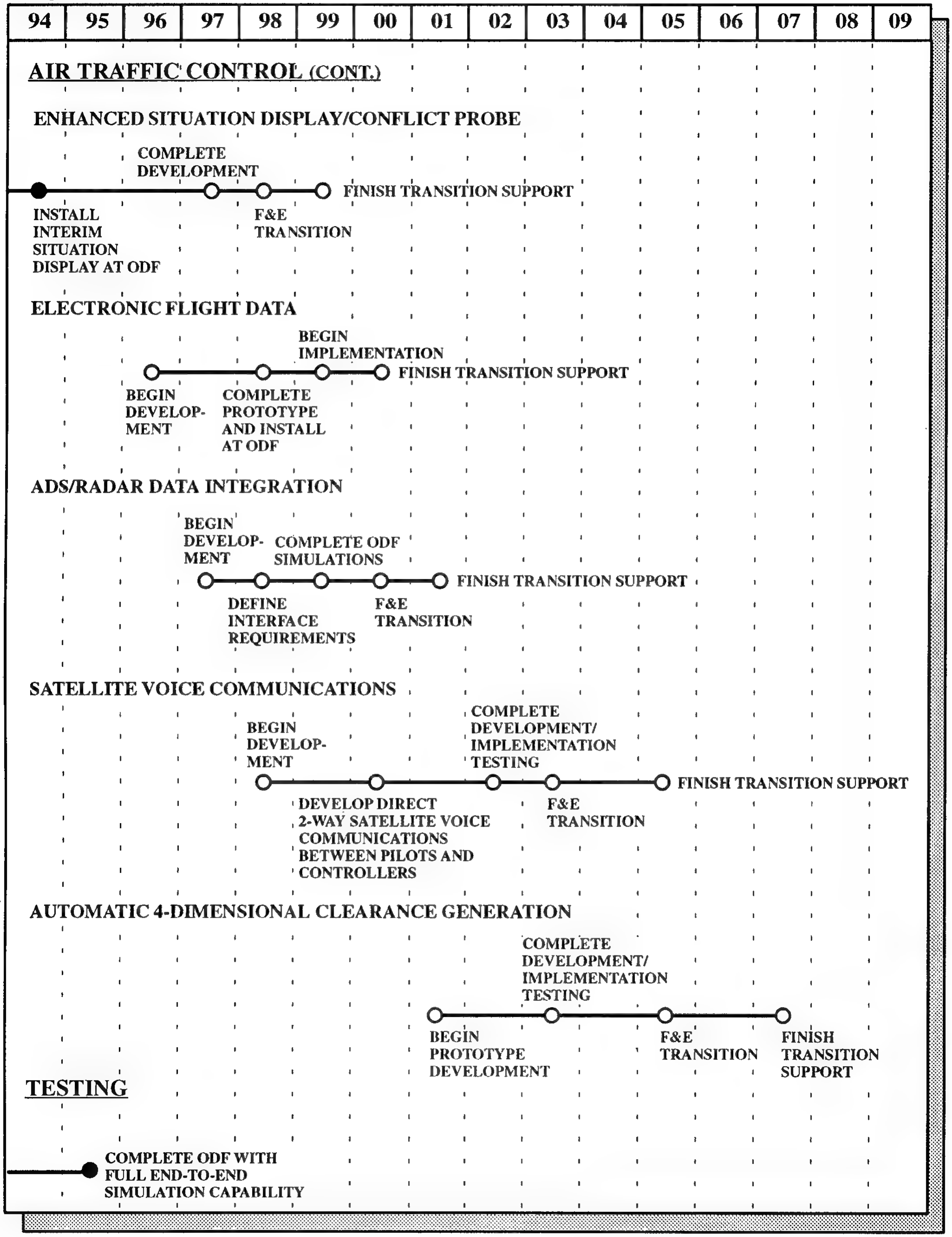
Testing

The oceanic development facility will be the primary test facility for all oceanic developmental and implementation testing.

Project 021–140: Oceanic Air Traffic Automation



Project 021–140: Oceanic Air Traffic Automation (continued)



021–180 Terminal ATC Automation (TATCA)

Purpose: This project will develop air traffic automation aids to assist both controllers and managers in optimizing traffic flow in terminal airspace. This project will also facilitate expeditious implementation of these aids at selected ARTCC's and/or terminal radar approach controls (TRACON's).

Approach: The TATCA program consists of three projects: the Converging Runway Display Aid (CRDA), the Controller Automated Spacing Aid (CASA), and the Center/TRACON Automation System (CTAS). Terminal operations analyses show that a leading cause of delays is losing capacity during instrument meteorological conditions (IMC). For example, many airports use multiple runways to land aircraft during visual meteorological conditions, but are restricted to a single arrival runway during IMC. CRDA is proving to be an effective automation tool for increasing arrival capacity during IMC. In particular, CRDA allows two converging runway arrival streams to be maintained in IMC. Through software changes in existing automated radar terminal system (ARTS) processors, CRDA uses the ghosting technique to provide geometric spacing aids on existing displays for sequencing and spacing aircraft. The CRDA project transitioned to an F&E phase in 1992 and provides the basis for developing ghosting applications under CASA. CASA will explore using the ghosting technique to merge traffic streams to a fix. The ghosting technique enhances a controller's ability to space merging aircraft precisely, thereby improving airspace utilization.

The CTAS project is currently undergoing prototype laboratory development, field development/evaluation, specification development, and site adaptation activities. CTAS uses auxiliary workstation processors interfaced to existing ATC processors to project future aircraft locations, develop a coordinated arrival traffic plan, and provide ATC advisories to help controllers meet the plan. The four CTAS products are the traffic management advisor (TMA), the final approach spacing tool (FAST), the descent advisor (DA), and the expedite departure path (EDP). The TMA provides ARTCC and TRACON controllers with automation aids for sequencing and spacing aircraft in a coordinated plan as far as 200 nautical miles from the airport. FAST provides optional advisories for TRACON controllers to sequence and space aircraft on final approach. The DA will provide Center sector controllers with top-of-descent points, speed, altitude, and heading advisories that will help them meet the TMA-generated traffic plan. EDP provides controllers with optional advisories to integrate departure airport traffic with the surrounding airport traffic flow. Longer-term TATCA activities focus on fully developed terminal automation techniques integrated with other ATC and cockpit automation capabilities.

To minimize technical risk and provide early products, the project places priority on delivering a developmental system to the field at the earliest possible date. Prototyping in developmental laboratories is used to develop the automation logic and its associated human-system interfaces. Prototypes are then taken to ATC facilities for field development in an operational environment. Following field development, system specification development for each CTAS product will be completed prior to each product's transition to F&E. Automated site adaptation procedures will be developed and validated at a field development site. At the conclusion of this effort, hardware, software, specifications, and automated site adaptation procedures for each CTAS product will be provided for transition to F&E.

Related Projects: 021–110 Advanced Traffic Management System (ATMS)/Operational Traffic Flow Planning (OTFP) and 021–190 Airport Surface Traffic Automation (ASTA). Capital Investment Plan projects: 21–06 Traffic Management System (TMS), 21–12 Advanced Automation System (AAS), 21–13 Automated

En Route Air Traffic Control (AERA), 41–21 En Route Software Development, 62–20 Terminal ATC Automation (TATCA), 62–21 Airport Surface Traffic Automation (ASTA), 62–24 National Implementation of the "Imaging" Aid For Dependent Converging Runway Approaches, and 63–21 Integrated Terminal Weather System (ITWS).

Products:

- TMA, FAST, DA, and EDP hardware, software, and specifications
- CASA Software/Functional Enhancements

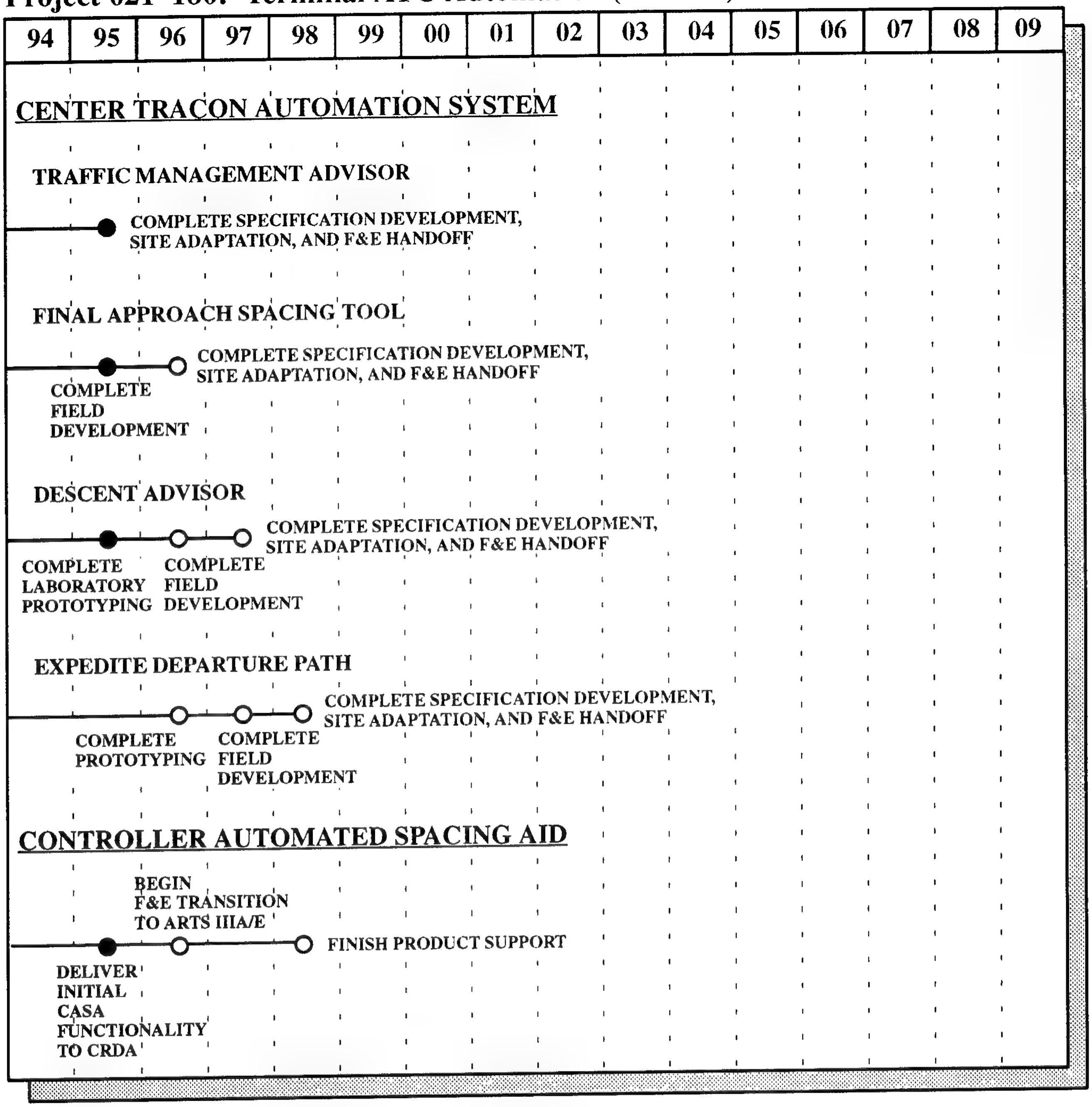
1995 Accomplishments:

- Complete DA laboratory prototyping.
- Complete FAST field development.
- Complete TMA specification development, site adaptation, and F&E handoff.
- Complete CASA prototype for Philadelphia.
- Deliver initial CASA functionality to CRDA.

Planned Activities: In 1996, CASA functionality prototyping and simulation with active controller participation will continue, possibly leading to a new software build. Also in 1996, testing at the Federal Aviation Administration Technical Center will begin on the new software to support F&E transition to ARTS IIIA/E. CASA product support will continue through 1998.

In 1996, development activities will continue on the CTAS products. FAST specification development and site adaptation procedures will be completed with F&E handoff in 1996. DA field development will be completed in 1996, with specification development, site adaptation, and F&E handoff in 1997. EDP prototyping will be completed in 1996, and field development will be completed in 1997. Specification development, site adaptation, and F&E handoff will follow in 1998. The CTAS component of this project will end in 1998.

Project 021–180: Terminal ATC Automation (TATCA)



021–190 Airport Surface Traffic Automation (ASTA)

Purpose: This project will develop an enhanced surface safety system, using airport surface detection equipment (ASDE-3) radar ground sensors, ARTS, differential corrected global positioning system (DGPS), and airport movement area safety system (AMASS) to reduce taxi delays and increase surface capacity.

Approach: This project has changed in scope from preventing runway incursions to reducing taxi delays and increasing surface capacity because the runway incursion functions have transitioned to F&E. The ASTA project examines the roles and responsibilities of controllers, pilots, and ground vehicle operators operating on the airport. ASTA has three main elements: commercial air carrier identification, general aviation/vehicle identification, and a surface movement advisor. This project will develop technical and operational specifications that evolve into one preproduction prototype for each element. The three prototypes will be integrated into one production-level system and installed at 37 high-density airports that have ASDE-3/AMASS. Additionally, the ASTA project is laying the groundwork for future tower control computer complex (TCCC) interface requirements. A critical part of the overall ASTA project is to share information with the Terminal Air Traffic Control Automation project and the departure sequencing function of the Traffic Management System project to create an interrelated arrival/departure sequencing system.

For the commercial air carrier identification element, ASTA will combine surveillance information from ASDE-3 radars, DGPS, and other potential ground movement sensors. All airports slated to receive ASDE-3/AMASS equipment under the F&E program will also receive ASTA. At those airports not equipped with ASDE-3/AMASS, ASTA will use other potential ground movement sensors, such as DGPS surveillance data link, for detecting aircraft and vehicles.

The general aviation/vehicle identification element is a key ASTA functionality. Currently, there is no requirement for AMASS to display data tags. ASTA will assist controllers by displaying target locations with alphanumeric data tags for general aviation aircraft. Furthermore, ASTA will provide positive target identification for special vehicles such as fire, rescue, and snow plows.

The surface movement advisor element will automatically provide the controller with optimal arrival/departure taxi routes in all weather conditions and monitor conformance to assigned route clearance.

Related Projects: 021–110 Advanced Traffic Management System (ATMS)/Operational Traffic Flow Planning (OTFP), 021–220 Multiple Runway Procedures Development, 021–180 Terminal ATC Automation (TATCA), 031–110 Aeronautical Data Link Communications and Applications, and 051–130 Airport Safety Technology. Capital Investment Plan projects: 21–06 Traffic Management System (TMS), 21–13 Automated En Route Air Traffic Control Automation (AERA), 24–12 Mode S, 24–14 Airport Surface Detection Equipment (ASDE-3) Radar, 62–20 Terminal ATC Automation (TATCA), 62-21 Airport Surface Traffic Automation (ASTA), and 62-23 Airport Movement Area Safety System (AMASS).

Products:

- Concept development and demonstration
- Communications architecture
- Aircraft and vehicle identification tags on the ASDE-3/AMASS display
- Aircraft and special vehicle movement conformance monitoring and alerting system
- Dynamic surface traffic management planning process for arrivals, departures, and taxiing aircraft
- Automatic coordination of surface traffic management automation with other ATC automation systems
- Preproduction prototype and testbed

- System specifications to produce 37 ASTA systems

1995 Accomplishments:

- Complete system specification to integrate GDPS data with ASDE-3/AMASS and aircraft/vehicle data tags.

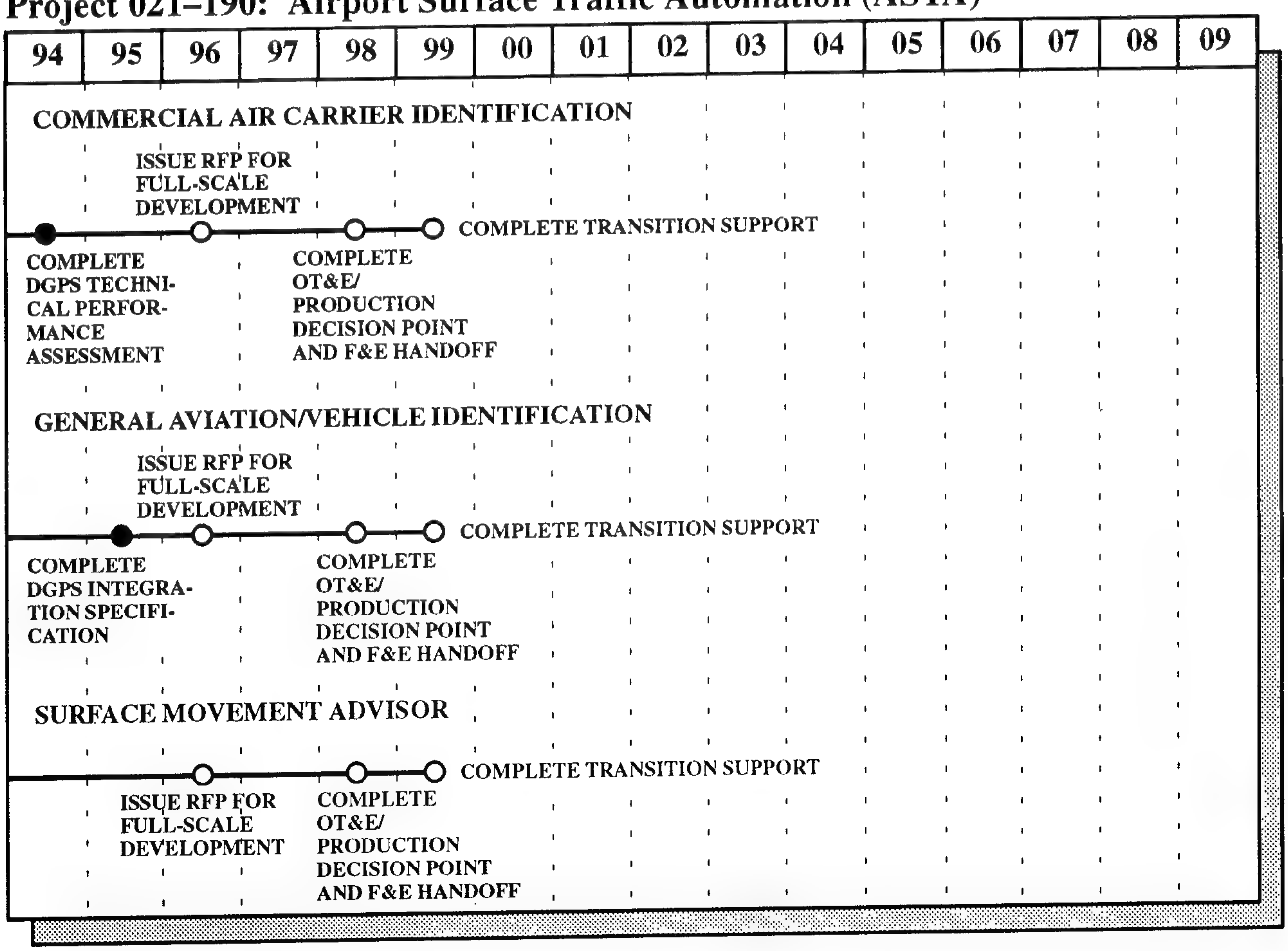
Planned Activities: In 1996, a request for proposal (RFP) for full-scale development will be issued for the commercial air carrier identification element, with contract award in 1997. In early 1998, a preproduction unit will be delivered for operational test and evaluation, leading to a 1998 production decision point and F&E handoff.

In 1996, an RFP for full-scale development will be issued for the general aviation/vehicle identification element, with contract award in 1997. In early 1998, a preproduction unit will be delivered for operational test and evaluation, leading to a 1998 production decision point and F&E handoff.

In 1996, a detailed system specification will be completed for the surface movement advisor element and an RFP for full-scale development will be issued, with contract award in 1997. In early 1998, a preproduction unit will be delivered for operational test and evaluation (OT&E), leading to a 1998 production decision point and F&E handoff. This element will be fully integrated with both the commercial air carrier identification and general aviation/vehicle identification elements.

This project will provide transitional support through 1999, at which time the project will end.

Project 021–190: Airport Surface Traffic Automation (ASTA)



021–210 Tower Integrated Display System (TIDS)

Purpose: This project will resolve tower space constraints and make available much needed space for future enhancements. TIDS will consolidate the displays and instrumentation for airport environmental data and control equipment used in towers.

Approach: A market survey was conducted to determine the availability of systems capable of meeting air traffic requirements with a minimal developmental effort. The results were used to determine an initial set of TIDS requirements and an appropriate acquisition strategy to field a TIDS in the near term. Prototyping activities are being conducted to mitigate the risk of procuring a primarily commercial off-the-shelf/ non-developmental item TIDS. The prototype will be used to refine system interfaces and computer/human interface requirements.

Further development efforts in this project will depend on a decision point resulting from the AAS program review. A key factor to be considered is the AAS restructuring with respect to the tower control computer complex. TIDS may be a replacement for TCCC, an interim step to TCCC, or a complementary system for use in non-TCCC towers.

Related Projects: 021–190 Airport Surface Traffic Automation (ASTA). Capital Investment Plan projects: 23–09 Automated Weather Observing System (AWOS), 24–08 Runway Visual Range (RVR), 43–12 Upgrade Low-Level Windshear Alert System (LLWAS) to Expanded Network Configuration, and 43–13 Digital Altimeter Setting Indicator (DASI) Replacement.

Products:

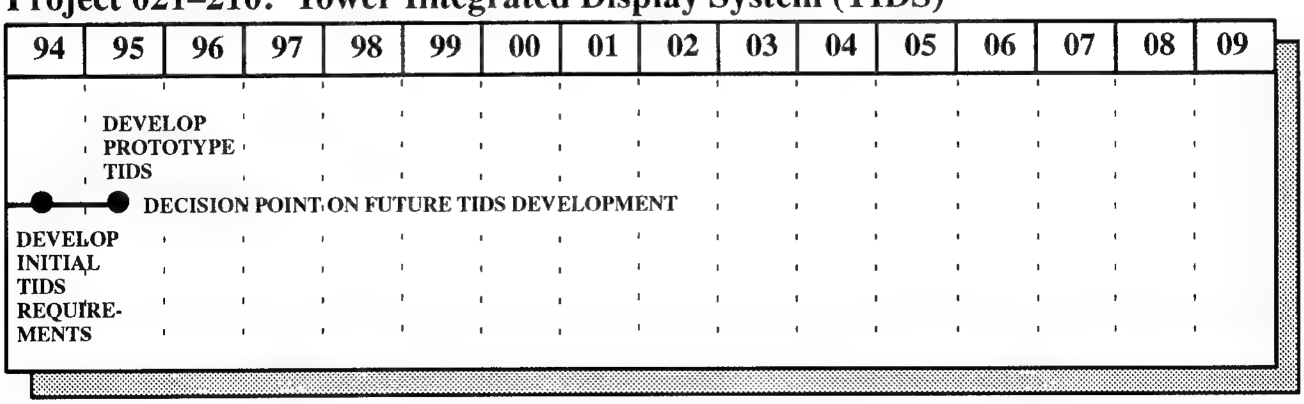
- TIDS requirements/appropriate acquisition strategy
- Prototype TIDS
- Future products to be determined following AAS decision point

1995 Accomplishments:

- Develop prototype TIDS.
- Complete risk mitigation analyses.

Planned Activities: Future activities for this program are on hold pending decisions concerning automation requirements at non-TCCC airports. Once these decisions are made, final TIDS requirements will be determined, and the research and development activities required for an appropriate acquisition strategy will be redefined.

Project 021–210: Tower Integrated Display System (TIDS)



021–220 Multiple Runway Procedures Development

Purpose: This project will develop ATC procedures to reduce airport delays by more fully utilizing multiple-runway capacity during instrument meteorological conditions. This project will investigate using precision runway monitor (PRM) technology, including electronically scanned antenna systems with higher update rates, in conjunction with advanced techniques for reducing parallel runway spacing standards to less than 3,400 feet. Air traffic procedures and flight standards criteria for simultaneous triple and quadruple instrument flight rules (IFR) parallel approaches will also be developed and validated. Requirements and techniques for improved surveillance and navigation capabilities will be developed to support these procedures.

Approach: The FAA completed demonstrations of electronically scanned and "back-to-back" antenna PRM technologies resulting in acceptance of simultaneous, independent approaches to dual parallel runways spaced as closely as 3,400 feet. The PRM Program Office upgraded the Raleigh-Durham PRM system to commissionable status and is procuring additional PRM systems for five airports that satisfy the 3,400 feet spacing standard. Additionally, real-time simulations have shown the value of a final monitor aid (FMA), based on high-resolution color displays with a controller alert aid. These displays receive surveillance inputs from airport surveillance radar (ASR)-9 or mode select (Mode S) discrete addressable secondary radar system with data link, for monitoring parallel runway operations.

This project will conduct additional simulations and analyses to develop national standards and ATC procedures for parallel runways using PRM and FMA technologies. Further research efforts on reducing runway spacing standards will focus on allowing approaches to parallel runways with less than 3,400 feet separation. The results of these studies for dual parallel runways will provide the basis for developing the spacing standards for closely spaced triple and quadruple parallel runways. This project will provide data and recommendations to the Air Traffic Service for formulating standards and procedures.

Related Projects: 021–180 Terminal ATC Automation (TATCA) and 033–110 Terminal Area Surveillance System. Capital Investment Plan projects: 62–20 Terminal ATC Automation (TATCA) and 64–27 Precision Runway Monitor.

Products:

- Data and recommendations to develop approach standards for closely spaced dual, triple, and quadruple runways
- ATC simulation evaluations of IFR procedures for triple and quadruple parallel runways using existing and improved runway monitoring systems
- Technical reports on simulation results and risk analyses
- Prototype graphics-oriented computer tool for displaying airspace structures and for evaluating airspace design performance

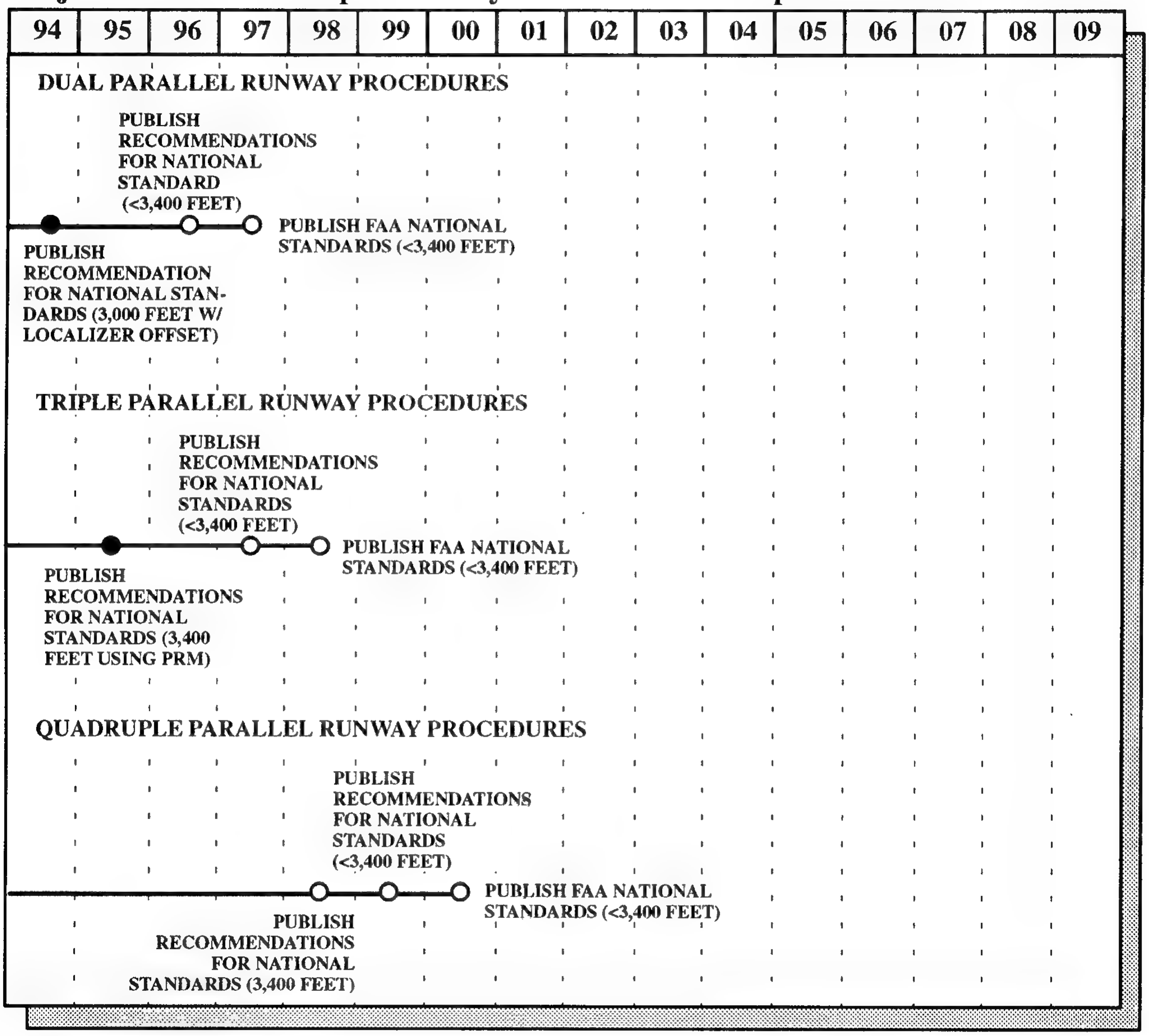
1995 Accomplishments:

- Publish FAA national standards for dual parallel runways with 3,000 feet spacing using the PRM and offset localizer.
- Develop recommendations for triple parallel runways with 3,400 feet separation using electronically scanned PRM technology.

Planned Activities: In 1996, research will continue on the combined use of electronically scanned PRM technology and advanced techniques for possible further reduction of dual runway separation standards to less than 3,400

feet. Recommendations will be developed for approaches to quadruple parallel runways with 3,400 feet separation using PRM in 1998. Dual, triple, and quadruple standards for parallel runways with less than 3,400 feet spacing will be accomplished in 1996, 1997, and 1999, based on PRM and advanced navigation/landing systems. FAA national standards for dual, triple, and quadruple parallel runways with less than 3,400 feet spacing will be published in 1997, 1998, and 2000, respectively. Publishing these standards will satisfy the project's original purpose. Advanced techniques include potentially using state-of-the-art autopilots, the global positioning system (GPS), and collision avoidance logic in controller displays.

Project 021–220: Multiple Runway Procedures Development



021–230 Wake-Vortex Separation Standards

Purpose: Wake-vortices, particularly those generated by large transport aircraft, can present significant hazards to following aircraft in single runway operations. Parallel runway operations may also be severely affected by vortices which can propagate great distances while in ground effect. This project will focus on safely reducing separation standards leading to increased capacity in the terminal area. These gains will be accomplished by understanding wake-vortex strength, duration, and transport characteristics, particularly as the vortices experience ground effect in the terminal environment. Potential methods to detect and avoid wake-vortices will be examined to enhance airspace use, decrease delays, and increase airport capacity in instrument meteorological conditions.

Approach: Current air traffic operations will be assessed to determine actual traffic spacing used under visual flight rules conditions. Vortex strength, decay, and transport characteristics, as well as the meteorological conditions that affect these characteristics, will be examined at selected, high traffic airports. Data from tower fly-by tests and other previously collected data will be combined with new data to provide a basis for reviewing existing separation standards and recommending modifications. Flight test simulations will be designed and conducted to determine if reducing the separation standards currently used under IFR conditions is feasible. Issues such as closely spaced parallel and converging runways, departure delays, and potential departure sequencing will also be explored through simulation.

Existing aircraft weight classifications will be reviewed, and a determination will be made as to whether the weight classifications and corresponding separations can be modified to improve single runway operations.

This project will include a joint effort with NASA to develop models and simulation techniques that characterize wake-vortex hazards. A memorandum of agreement was signed that commits the FAA and NASA to a joint research effort.

Related Projects: 021–180 Terminal ATC Automation (TATCA); 024–110 Aviation System Capacity Planning; and 042–110 Aeronautical Hazards Research. Capital Investment Plan projects: 62–20 Terminal ATC Automation (TATCA) and 63–21 Integrated Terminal Weather System (ITWS).

Products:

- Feasibility report on reducing separation standards in the terminal area
- Recommendations on aircraft weight classifications
- Separation algorithms for TATCA based on leading/following aircraft types
- Wake-vortex models/simulations
- Wake-vortex detection system
- Automated wake-vortex spacing system

1995 Accomplishments:

- Develop wake-vortex sensor requirements.
- Develop wake-vortex transport and decay model in ground effect.
- Revise aircraft spacing/classification recommendations.
- Select sensor technology for further development.

Planned Activities: Through 2001, this project will coordinate closely with NASA, industry, and

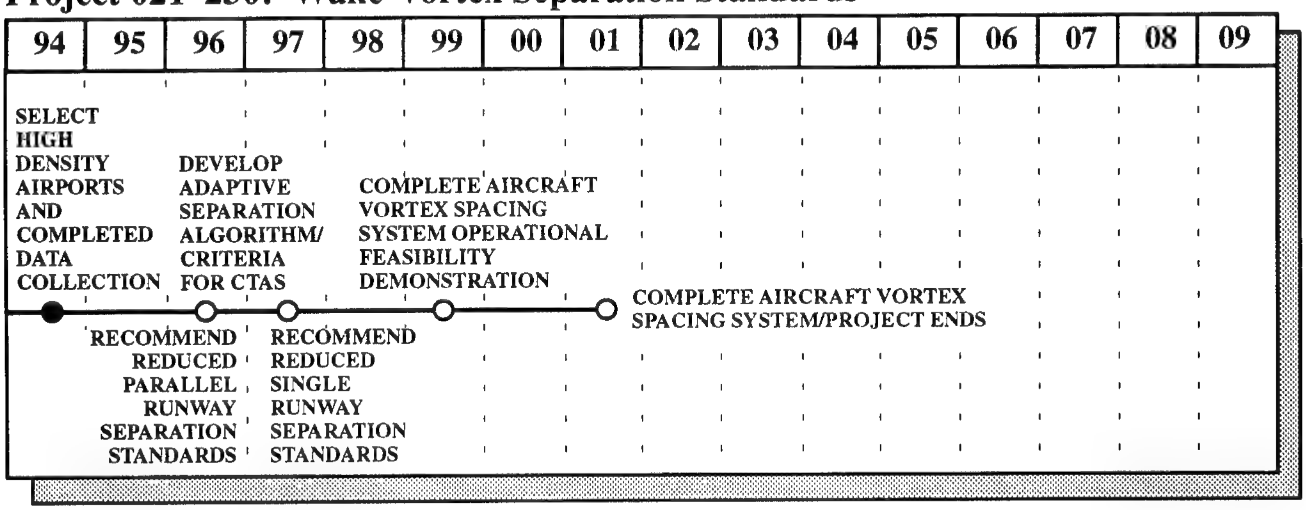
the international community on wake-vortex research. In particular, NASA will continue through 1999 to develop models and simulation techniques that characterize wake-vortex hazards and conduct flight test validation. Additionally, NASA research will be a key element in producing an effective wake-vortex sensor and aircraft vortex spacing system.

Flight test data on closely spaced parallel runways will be analyzed to develop new parallel runway separation criteria for FAA approval in 1996. Also in 1996, an adaptive separation algorithm and criteria will be developed for the center TRACON automation system (CTAS), followed by an operational demonstration of the parallel runway system. Recommendations to reduce parallel runway separation standards/weight classifications will be published in 1996, followed by reduced single runway separation standards in 1997.

In 1997, development work will be completed on a wake-vortex detection system. This system will be used to validate wake-vortex transport decay models. In 1998, wake-vortex integrated detection and prediction systems will be validated, leading to an operational feasibility demonstration of the aircraft vortex spacing system in 1999. This system has the potential for increasing airport capacity even further. From 1999–2001, the aircraft vortex spacing system will undergo testing and refinement prior to operational implementation. Final implementation is expected in 2001, at which time the project will end.

In parallel with the standards/system development work, this project will develop a computer-based wake-vortex training program in 1996.

Project 021–230: Wake-Vortex Separation Standards



022–110 Traffic Alert and Collision Avoidance System (TCAS)

Purpose: This project will develop, demonstrate, and assist in implementing an independent airborne collision avoidance capability to increase the safety and capacity of the National Airspace System. TCAS will increase safety by reducing midair collision risks. Capacity will be

increased by using the improved cockpit display capability provided by TCAS to aid capacity enhancements such as simultaneous approaches to parallel runways and pilot-maintained in-trail spacing. The aviation community will be provided with standards and certification guidance materials required for implementing the system.

Approach: There are three TCAS versions: I, II, and IV, each with successively increasing capabilities. TCAS I is under evaluation through a limited implementation program (LIP). TCAS II operational implementation has been completed; however, development work on enhanced logic changes will continue. TCAS IV development will continue through an LIP similar to TCAS I and II.

<u>TCAS I</u>

TCAS I generates traffic advisories to assist pilots in locating potential midair collision threats. The FAA has established a cost-shared contract with an avionics manufacturer to furnish TCAS I avionics for an LIP evaluation on several types of in-service commuter aircraft. This effort will provide operational and performance data on commercial TCAS I equipment in actual service.

<u>TCAS II</u>

TCAS II equipment, which includes a Mode S transponder, is intended for installation in transport category and high performance general aviation aircraft. TCAS II equipment will not only provide traffic advisories but will also compute vertical-plane resolution advisories that indicate the direction the aircraft should maneuver to avoid collisions. To ensure that maneuvers from two TCAS-equipped aircraft do not conflict, resolution advisories are coordinated between aircraft using the integral Mode S transponder.

Through an LIP, an operational TCAS II evaluation has been carried out on a number of in-service airline aircraft. Federal Aviation Regulations now require that all airplanes with more than 30 passenger seats operating in U.S. airspace be equipped with TCAS II. Development efforts will continue to enhance TCAS II by resolving technical and operational issues associated with implementation.

<u>TCAS IV</u>

The TCAS III airborne antenna report confirmed that current state-of-the-art TCAS antennas would not support horizontal resolution advisories. Therefore, alternative approaches will be developed to provide a horizontal resolution advisory capability. The prime candidate is a GPS-based system using Mode S data link.

TCAS IV equipment, intended for installation in transport category aircraft, is designed to generate traffic advisories and resolution advisories in both the horizontal and vertical planes. Maneuvers will be coordinated between similarly equipped aircraft. The FAA is supporting minimum operational performance standards development for TCAS IV by an RTCA special committee.

In response to congressional direction, the FAA has developed a plan to complete the remaining development and test efforts, and evaluate the TCAS IV system on airline aircraft in an LIP. Completing the development program and the LIP for TCAS IV will enable the aviation community to implement the most advanced airborne collision avoidance system as a user option.

Related Projects: 024–110 Aviation System Capacity Planning, 031–110 Aeronautical Data Link Communications and Applications, and 032–110 Satellite Navigation Program. Capital Investment Plan projects: 23–05 Aeronautical Data Link, 24–12 Mode S, and 63–05 Aeronautical Data Link Communications and Applications

Products:

TCAS I

- LIP — Reports on the TCAS I avionics evaluation to provide industry with guidance for TCAS I certification and operation

TCAS II

- LIP — Reports on TCAS II installation, certification, and operation on air carrier aircraft during routine operations
- TCAS II transition program report documenting TCAS II implementation program results and any required modifications
- TCAS II requirements document for certification in transport category aircraft
- ICAO standards and recommended practices that provide a basis for international certification and operational approval

TCAS IV

- RTCA minimum operational performance standards that define required performance under standard operating conditions
- System safety study assessing the overall safety characteristics associated with using the TCAS IV collision avoidance system
- LIP — Report on TCAS IV installation, certification, and operation in air carrier aircraft

1995 Accomplishments:

- Implement logic modification 6.04A for TCAS II.
- Complete TCAS II transition program.
- Complete TCAS IV surveillance subsystem design.

Planned Activities:

TCAS I

In accordance with Federal Aviation Regulations, all 10 to 30 seat turbine-powered commuter aircraft must be equipped with TCAS I by March 31, 1997. In 1996, the FAA will continue a multiyear TCAS I transition program to assist aircraft operators with TCAS I implementation in the National Airspace System. The transition program will continue through 1997. Periodic transition program reports will provide guidance on installation, crew training, and system operation.

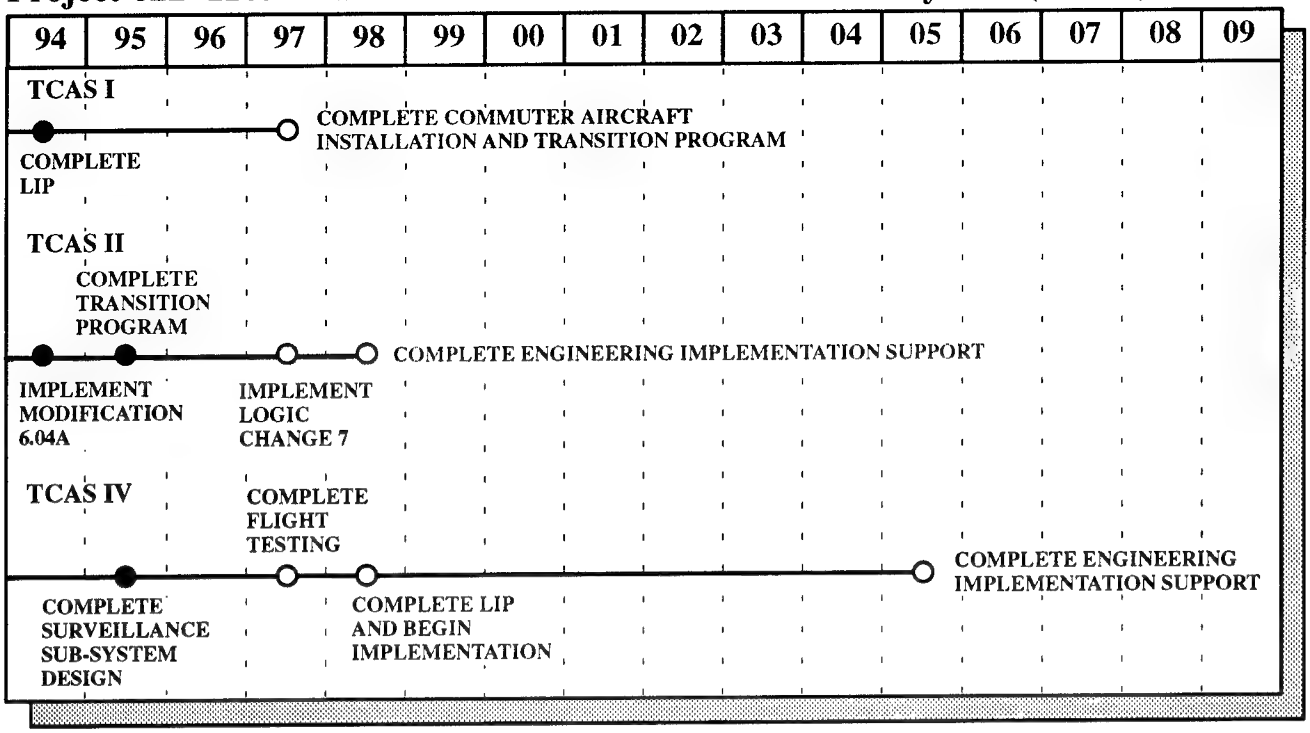
TCAS II

In accordance with Federal Aviation Regulations, all commercial aircraft with more than 30 passenger seats were required to be equipped with TCAS II by December 30, 1993. In 1996, the FAA will continue to work with the aviation community to resolve technical and operational issues associated with TCAS II implementation. Development work will continue on logic change 7 until implementation in 1997. Engineering support will continue through 1998.

TCAS IV

Flight testing on TCAS IV will be conducted from 1996–1997. An LIP will be conducted in 1998 to determine the certification and operational requirements for TCAS IV. At the conclusion of the LIP in 1998, TCAS IV will be available for airline implementation. Engineering support, such as developing logic modifications to reduce unnecessary alert rates, will continue through 2005.

Project 022–110: Traffic Alert and Collision Avoidance System (TCAS)



022–140 General Aviation and Vertical Flight Technology Program

Purpose: In response to the Administrator's policy, this project has undergone a change in scope to include research into revitalizing the general aviation industry. This project will identify, initiate, and coordinate actions to facilitate introducing and expanding technology applicable to general aviation and vertical flight in the NAS. Research, engineering, and development efforts will focus on air traffic rules and operational procedures; heliport/vertiport design and planning; aircraft/aircrew certification and training; and emerging technology applications.

The general aviation portion of this project is a joint NASA/FAA technology program. The major objectives are to stimulate the industry and create jobs for airframe manufacturers, the propulsion industry, avionics shops, airports, and supporting industries. Research will include rapidly introducing new cockpit display and control technologies; integrated ATC procedures; expert decisionmaking systems; enhanced airspace utilization; enhanced ground/cockpit information systems; and other technology initiatives.

Approach: The Rotorcraft Master Plan envisions using advanced vertical flight technologies to provide scheduled short-haul passenger and cargo service for up to 10 percent of the projected domestic air travel. Significant reductions in the estimated $5 billion national annual aviation delay cost could be realized by such aircraft.

Recognizing the potential for advanced vertical flight aircraft to provide passenger service, Public Law 102-581 requested that a Civil Tiltrotor (CTR) Development Advisory Committee be established. This committee will evaluate the technical feasibility and economic viability of developing CTR aircraft and infrastructure to

support incorporating tiltrotor technology into the national transportation system.

To meet the Public Law requirements and the FAA goals, research will be conducted in the following areas: (1) air and ground infrastructures to permit operations under visual and instrument flight conditions en route and in the terminal area; (2) operations safety; (3) operations noise reduction; (4) training and certification procedures; and (5) CTR technology economic viability and potential benefits analyses.

The FAA is responsible for developing the appropriate infrastructure and regulations in parallel with industry's actions and commitment to develop and operate market-responsive aircraft. The program will focus on the following technical subprogram areas: air infrastructure, ground infrastructure, and aircraft/aircrew. R,E&D efforts will consist primarily of studies and analyses, simulations, model development, and flight testing. The work will be performed by NASA, MITRE, the Volpe National Transportation Systems Center, support contractors, and universities through grant programs.

Air Infrastructure

This subproject will provide research to enable reliable, all-weather operations for general aviation and vertical flight passenger and cargo aircraft. The research results will include developing nonprecision and precision GPS terminal instrument approach and departure procedures criteria; developing generic rotorcraft simulators; developing rotorcraft IFR approach and departure ascent/descent angles; improving low altitude navigation and air traffic control services using GPS, data link, and satellite communications technology; air route design; and noise abatement procedures. GPS will be a major element in this enhancement.

Ground Infrastructure

The ground infrastructure research will address heliport and vertiport design and planning issues, including the terminal area facilities and ground-based support systems that will be needed to implement safe, all-weather, 24-hour flight operations. Developing obstacle avoidance capabilities is a critical design-related effort. Research will include enhanced ground/cockpit information systems, noise abatement and emissions reduction, increased airport availability, and applying lessons learned from detailed accident/operations analyses. Simulation will be used extensively to collect data, analyze scenarios, and provide training to facilitate safe operations.

Aircraft/Aircrew

With the necessity for increased simulation use, this subproject will develop the criteria and guidance for simulators used for crew member training/evaluation. Training procedures will be established to reduce the human element causal factor in general aviation and vertical flight accidents.

Aircraft/aircrew research will: develop minimum performance criteria for visual scenes and motion-base simulators; evaluate state-of-the-art flight performance for cockpit design technology; develop improved training techniques to enhance decisionmaking reactions; and develop crew and aircraft performance standards for display and control integration requirements. Research will also be conducted to develop certification standards for both conventional and advanced technology vertical flight aircraft.

Related Projects: 021–140 Oceanic Air Traffic Automation, 024–110 Aviation System Capacity Planning, 025–110 National Simulation Capability (NSC), 031–120 Satellite Communications Program, 032–110 Satellite Navigation Program, 063–110 Propulsion and Fuel Systems, 064–110 Flight Safety/Atmospheric Hazards, and 091–110 Environment and Energy. Capital Investment Plan projects: 24–07 Microwave Landing System (MLS), 61–22 ATC Applications of Automatic Dependent Surveillance (ADS), and 63–05 Aeronautical Data Link Communications and Applications.

Products:

- Nonprecision and precision GPS approach terminal instrument procedures criteria
- New cockpit technologies
- ATC route standards, procedures, and models
- Vertiport/heliport design standards
- Improved noise planning tools
- vertical flight noise abatement procedures
- Rotorcraft simulator standards
- Aircrew training and certification requirements
- Cost/benefit assessments for deploying advanced vertical flight technologies

1995 Accomplishments:

- Publish economic feasibility and airport/airspace capacity impact analyses for a civil tiltrotor-based shorthaul transportation system.
- Develop helicopter nonprecision GPS approach terminal instrument procedures (TERPS) criteria.
- Conduct simulated flight tests with NASA on IFR approaches and departures to develop TERPS criteria and operating procedures for heliports and vertiports.
- Complete accident prevention audio and visual training aids and an enhanced decisionmaking training manual for helicopter pilots.
- Publish the Rotorcraft Noise Abatement Plan, community planning handbooks, and computer planning models on rotorcraft noise issues.
- Conduct general aviation innovative aircraft design competition jointly with NASA.

Planned Activities:

<u>Air Infrastructure</u>

In 1996, noise data collection from operational profiles will be conducted. Helicopter nonprecision and precision GPS approach TERPS criteria will be developed in 1996 and 1997, respectively. These TERPS will be published in 1996 for nonprecision approaches and in 1997 for precision approaches. In 1997, low noise conversion corridor criteria for rotorcraft will be developed to support publishing terminal area IFR procedures for steep angle approaches and departures. Also, ATC and local controller training material related to noise abatement procedures will be published, and development work on generic rotorcraft simulators will be completed.

In 1998, noise abatement and control advisory circular materials will be published, and generic rotorcraft instrument procedures and air traffic standards will be established.

In 2002, low altitude route standards and air traffic control management procedures will be published for regional vertiport systems.

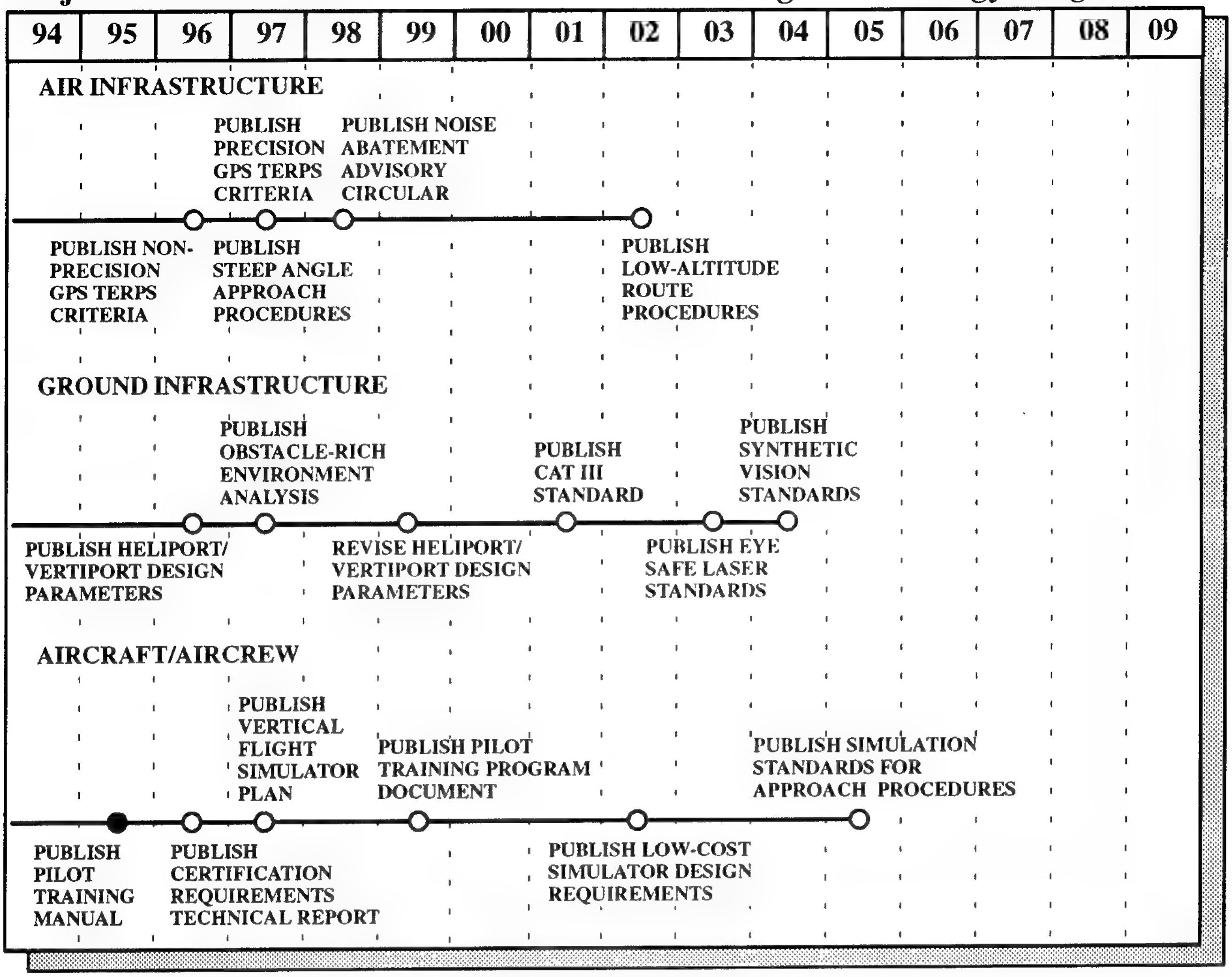
Ground Infrastructure

In 1996, test results and analyses of heliport and vertiport design parameters will be published, including minimum required visual flight rules airspace for curved approaches and departures, minimum parking and maneuvering areas, marking and lighting, and rotorwash protection requirements. A simulation-based analysis of pilot performance in an obstacle-rich environment will be published in 1997. Results of this study will be used to evaluate necessary heliport and vertiport design criteria. Revisions to heliport and vertiport design parameters will be published in 1999. Further research and development work is planned to develop heliport/vertiport standards for Category (CAT) III landings in 2001; standards for eye-safe lasers in 2003; and standards for synthetic vision/infrared sensors in 2004.

Aircraft/Aircrew

In 1996, a technical report supporting aircraft cockpit display certification requirements will be published. In 1997, the National Vertical Flight Simulator Plan for joint industry/local government advanced technology vertical flight demonstration program will be published. Also in 1997, video tapes on enhanced decisionmaking for pilot training will be completed. In 1998, priority pilot training tasks will be established. In 1999, a document will be published and distributed to operators for assistance in establishing pilot training programs. In 2000, the Vertical Flight Simulation National Plan will be integrated into the overall National Simulation Plan (including fixed wing). In 2001, the expert pilot training techniques will be integrated into training syllabi. In 2002, low cost simulator design requirements will be published, and in 2005, simulation standards for approach procedure development will be published.

Project 022–140: General Aviation and Vertical Flight Technology Program



022–150 Flight Operations and Air Traffic Management Integration

Purpose: A cornerstone of the future air traffic management system will be direct information exchange between flight management system (FMS) computers and ground-based ATM computers via data link. Current FMS utilization in today's air traffic system environment is estimated by the user community at approximately 30 percent. This underutilization has resulted in the need to better integrate the aircraft FMS with the ground ATM. This project will develop the capability to integrate flight management computer operations with ground-based air traffic management automation. Integrating FMS and ATM operations via data link is expected to increase airspace capacity and ensure more efficient flight operations along more flexible, conflict-free routes.

Approach: Integrating FMS with ATM in the near term can be accomplished by adapting existing procedures to take advantage of FMS capabilities to save distance, fuel, and time on the aircraft

side. On the ATM side, there will be a reduction in communications and associated workload. The goal for the future will be to increase currently perceived FMS utilization by a factor of three. This integration must encompass all operational areas where the FMS is used to gain overall system benefits. These areas include terminal, en route, and oceanic airspace as well as the airport surface.

This project will continue to support working groups such as the Industry/FAA Advanced FMS Applications Task Force. The task force is involved in creating new procedures using existing FMS capabilities for curved approaches and departures at selected airports. Procedures validation will be accomplished through data collection/analysis, simulation, and flight testing. These procedures will then be adapted to support FMS-guided terminal operations nationwide.

This project's primary focus will be developing functional and operational requirements for an ATM-compatible FMS. These requirements will be used by industry as the standard to build the next generation FMS and retrofit current technology aircraft. This work will be accomplished through a cooperative agreement between FAA and industry. An additional product will be developing FMS flight operations and procedures that benefit from the new information exchange between the aircraft flight deck and the ground ATM system. This project also integrates ATM with airline operations centers (AOC's). AOC's include flight dispatcher activities such as flight planning, flight following, and distributing information to flight crews and traffic managers. The result of this FMS/ATM/AOC triad integration will be a synergistic system where the benefit is greater than the sum of the three components alone.

A key to successful FMS/ATM/AOC integration is developing automated communications among aircraft FMS, ground ATM, and AOC computers. This goal will be accomplished by developing a set of flight operations and air traffic management integration (FTMI)-specific data link operational requirements. These requirements will be included as part of an FAA/industry set of data link operational requirements that support air traffic and flight information services.

Related Projects: 021–110 Advanced Traffic Management System (ATMS)/Operational Traffic Flow Planning (OTFP), 021–140 Oceanic Air Traffic Automation, 021–180 Terminal ATC Automation (TATCA), 021–190 Airport Surface Traffic Automation (ASTA), 031–110 Aeronautical Data Link Communications and Applications, and 084–110 Flight Deck/ATC System Integration. Capital Investment Plan projects: 21–06 Traffic Management System (TMS), 21–13 Automated En Route Air Traffic Control (AERA), 61–22 ATC Applications of Automatic Dependent Surveillance (ADS), 62–20 Terminal ATC Automation (TATCA), and 63–05 Aeronautical Data Link Communications and Applications.

Products:

- Flight operations procedures and standards for FMS-guided curved approaches and departures at selected airports
- Flight operations procedures and standards for FMS-guided terminal operations nationwide
- Operational requirements document for the next generation ATM-compatible FMS
- Flight operations procedures and standards for FMS-guided en route and oceanic operations

1995 Accomplishments:

- Complete analysis to support flight standards for developing FMS-guided curved approaches and departures.

- Complete simulation demonstrating FMS capabilities to improve oceanic airspace utilization.
- Complete FMS/ATM/AOC operational concept and new FMS capabilities documents.

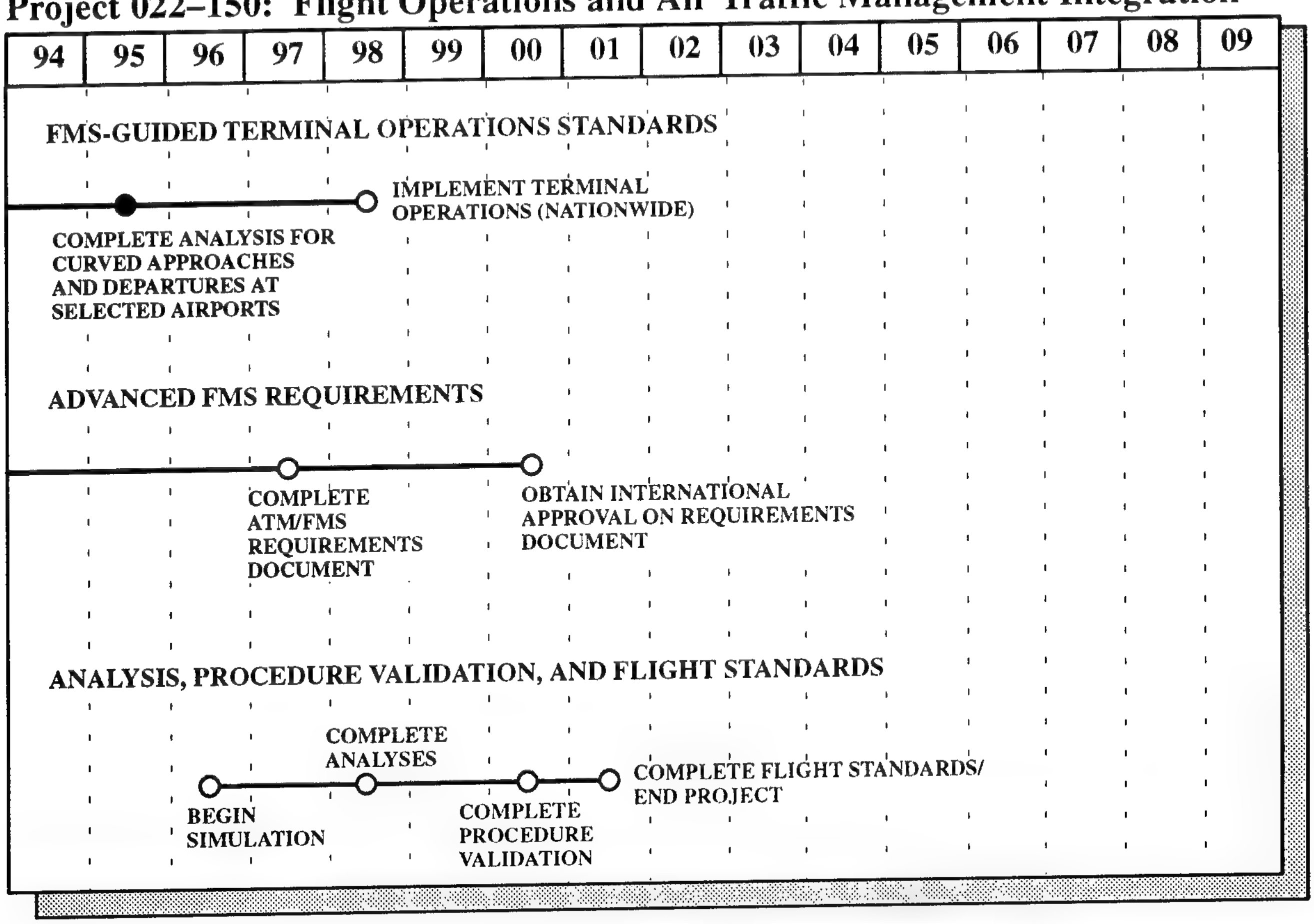
Planned Activities: In 1996–1997, analyses will be completed to support nationwide standards for FMS-guided terminal operations with implementation by 1998.

In 1996–1998, further simulation experiments involving FTMI scenarios will be conducted. Procedure validation will be conducted in parallel to simulations, and will be completed by 2000. Flight standards and guidance material will be completed in 2001.

An activity will continue in 1996 to develop an operational requirements document by 1997 for advanced FMS capabilities to ensure full integration of flight management and ATM operations. In 1998, work will begin on obtaining international agreement on the ATM-compatible FMS requirements document by 2000.

This project will end in 2001 when the FMS requirements are developed and if the ATM-compatible FMS requirements document receives international approval.

Project 022–150: Flight Operations and Air Traffic Management Integration



023–120 Separation Standards

Purpose: This project will provide quantitative guidance for domestic and international efforts to establish minimum vertical and horizontal separation standards. The ability to increase system capacity is directly related to separation standards. As new technology is introduced, separation standards will be reduced, resulting in increased system capacity. Another benefit will be significant improvements in fuel efficiency from flying more optimum flight profiles.

Approach: Tests will be conducted to provide quantitative guidance for determining domestic and oceanic separation minima permissible as new technologies are introduced. This effort will establish separation minima based on improved navigation, automatic dependent surveillance, other new technologies, and ATC improvements.

This project will analyze separation standards in the North Atlantic, South Pacific, Central East Pacific, North Pacific, and West Atlantic route systems. It will examine the impact of various system improvements on horizontal and vertical separation. Time-based navigation capabilities and associated ATC procedures will be analyzed to determine whether time-based longitudinal separation standards or distance-based standards are more appropriate.

Related Projects: 021–140 Oceanic Air Traffic Automation, 031–110 Aeronautical Data Link Communications and Applications, 031–120 Satellite Communications Program, 032–110 Satellite Navigation Program, and 032–120 Navigation Systems Development. Capital Investment Plan projects: 61–22 ATC Applications of Automatic Dependent Surveillance (ADS), 61–23 Oceanic Automation Program (OAP), 63–05 Aeronautical Data Link Communications and Applications, and 64–05 Augmentations for GPS.

Products:

- Reports on reduced horizontal oceanic separation feasibility
- Report on domestic and international general guidance material for establishing separation standard minima
- Data packages for coordinating international horizontal oceanic separation standards
- Reduced vertical separation data analyses, operational tests, and evaluations
- Rulemaking to enable reduced separation standards

1995 Accomplishments:

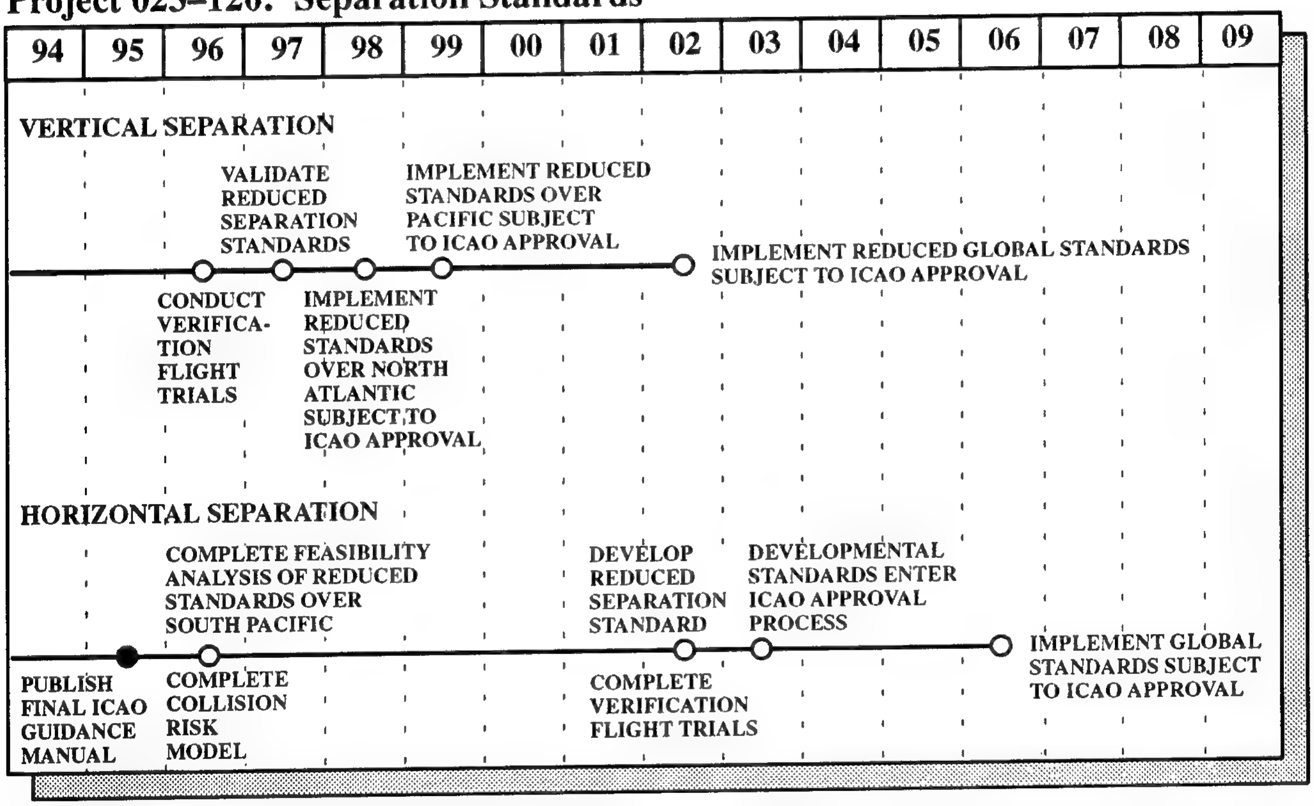
- Publish final ICAO general separation standards guidance manual.

Planned Activities: The North Atlantic Systems Planning Group will continue planning for vertical separation reduction over the North Atlantic. In 1996, this project will conduct verification flight trials on the current vertical separation standards to collect statistical data on aircraft altitude-keeping performance. This data will be used to verify that the theoretical calculations on reduced vertical separation are accurate. In 1997, flight trials will be conducted to validate reducing separation standards to 1,000 feet vertical above flight level 290 in the North Atlantic. In 1998, ICAO approval is expected for implementing reduced standards in the North Atlantic. Planning will continue for vertical separation standards reduction in Pacific airspace with possible implementation by 1999, subject to ICAO regional approval. Additional regional analyses will be conducted through 2001 to support the FAA's

goal of having a global oceanic vertical separation standard. The analyses will determine if certain oceanic regions will require a deviation from a global standard or if a global standard will suffice for all areas. ICAO approval on a global standard is expected by 2002.

In 1996, a new or revised collision risk model will be completed to provide quantitative guidance for establishing horizontal separation standards based on ADS/GPS/TCAS/two-way data link equipage. An analysis will be conducted in the South Pacific region to verify the feasibility of reducing horizontal separation standards from 120 miles to 30 miles. From 1997–2002, additional verification flight trials and analyses will be conducted in other oceanic regions to develop a global standard that reduces horizontal separation to 30 miles. In 2003, this developmental standard will enter the ICAO approval process to develop a worldwide standard by 2006. The FAA's goal is to eventually reduce oceanic horizontal separation standards to near-domestic limits (approximately 5 miles).

Project 023–120: Separation Standards



024–110 Aviation System Capacity Planning

Purpose: Twenty-three major metropolitan airports currently experience over 20,000 hours of annual delay due to capacity restraints. As the aviation industry continues to grow, the number of affected airports will increase, with projections showing 33 experiencing 20,000 hours of delay by 2002. This project studies airports and terminal airspace to recommend procedures, equipment, and physical facilities that will increase capacity, thereby reducing air carrier

delays. Additionally, this project examines new capacity enhancement technologies, procedures, and en route airspace restructuring to determine where these initiatives can be implemented for the greatest benefit.

Approach: A primary focus of this project is responding to near-term airport-driven capacity issues. As traffic demand at airports changes, research efforts are reallocated to meet the changing priorities. This dynamic environment is driven by constantly changing airline needs. Airport, airspace, tactical initiative, and capacity design teams currently active at 15 airports are comprised of airport operators, airlines, other users, and FAA representatives. Each team starts with a current airport and/or adjacent airspace environment simulation using actual operating data to establish a baseline. The team then develops a list of potential improvements to increase capacity and reduce delays by using a variety of simulation and queuing models, and tests their effect in the specific airport environment. Among the improvements investigated are airfield improvements such as new runways and runway extensions; improved approach procedures; and new facilities and equipment such as the precision runway monitor. Those improvements found to produce the greatest capacity increases, together with the estimated delay reductions and cost savings, are described and recommended for implementation in the final design team plans.

Design teams also address airspace structure and develop new designs and traffic flow modifications to accommodate more aircraft within the terminal airspace. Airspace redesign begins with simulating the air traffic control center airway environment using operational data to establish the baseline. The airspace design team then develops alternatives such as more direct routings; segregating jet, turboprop, and piston engine traffic; and relocating cornerpost navigational aids to allow for more arrival and departure routes. These alternatives are simulated to determine their effect on delay, travel time, sector loading, and aircraft operating cost. The most successful alternatives are then incorporated into a plan to redesign the airspace for increased capacity.

The Tactical Initiatives Team project, on the other hand, works to develop achievable, near-term solutions for chronic delay airports by focusing on resources under FAA control. This program is limited to initiatives that will produce results within 2 years.

Related Projects: 021–220 Multiple Runway Procedures Development, 021–230 Wake Vortex Separation Standards, 022–110 Traffic Alert and Collision Avoidance System (TCAS), 022–140 General Aviation and Vertical Flight Technology Program, 025–130 Air Traffic Models and Evaluation Tools, and 091–110 Environment and Energy.

Products:

- Aviation Capacity Enhancement (ACE) Plan
- Airport Capacity Design Team Plans
- Airspace Analysis Technical Plans
- Aviation Capacity Initiatives Report
- Aviation System Capacity Enhancement video
- Terminal Airspace Capacity Design Team Plans
- Tactical Initiatives Reports
- Aviation System Capacity Annual Report

1995 Accomplishments:

- Develop improved independent converging approach procedures and standards.
- Produce 1995 Aviation Capacity Enhancement Plan.

- Complete Airport Capacity Design Team plans for Seattle, Atlanta, Portland, San Diego, Las Vegas, and West Palm Beach.

- Complete Airspace Analysis Technical Plans.

- Complete Tactical Initiatives Report for Los Angeles and Orlando.

- Complete airspace analyses at Albuquerque, Boston, and Memphis ARTCC's.

- Complete Terminal Airspace Capacity Design Team plans at San Antonio, Salt Lake City, Tampa, Minneapolis, and Philadelphia.

Planned Activities: Airport Capacity Design Team efforts will continue at San Diego, New York (JFK, LGA, and EWR), Miami, Boston, St. Louis, Memphis, and Washington Dulles. The sequence of events is to conduct a study lasting approximately 12 to 18 months at each airport, followed by capacity improvement recommendations. These teams will develop Airport Capacity Design Plans for each airport by 1996.

In 1996, Airspace Analysis Technical Plans will be developed for Albuquerque, Boston, and Memphis ARTCC's. These plans will lead to airspace redesigns at these locations to improve traffic flows. The sequence of events is to study these airspaces for 2 years and then issue recommendations for capacity enhancements.

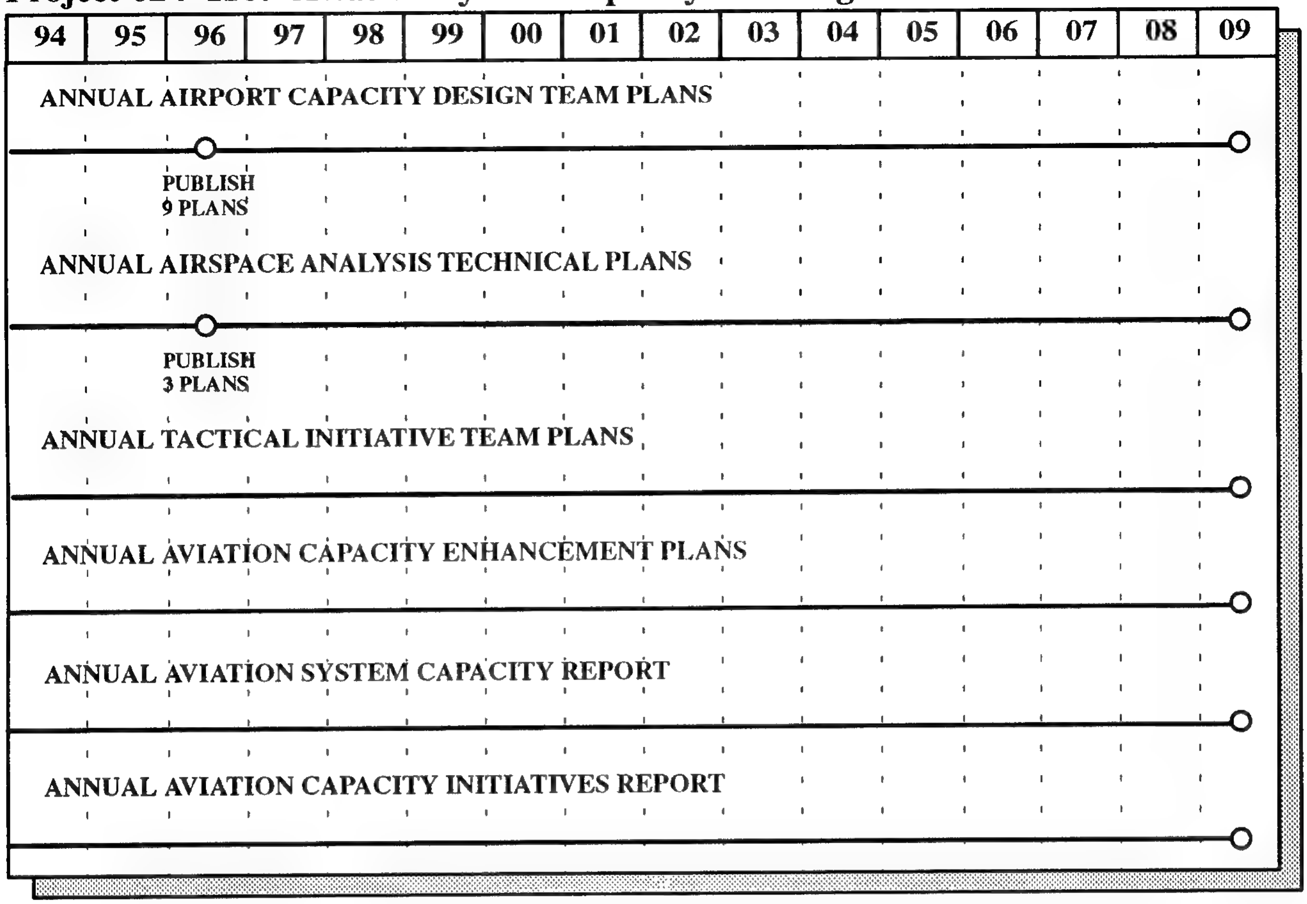
From 1996 to 1998, simulations and flight demonstrations will be conducted to determine if TCAS can be expanded for separation assistance. The FAA Strategic Plan goals include improved system efficiency, a reduction in controller workload, and enhanced safety.

In 1996, the Tactical Initiatives Team will investigate near-term solutions to capacity problems at the top 24 airports experiencing chronic delay. As technology evolves, the Tactical Initiatives Teams will continually analyze delay problems and develop new, near-term solutions.

In 1996, the Terminal Airspace Capacity Design Team will complete the capacity plans for Miami, Seattle, and Boston.

The following documents will be produced annually: the Aviation Capacity Enhancement Plan, the Aviation System Capacity Annual Report, and the Aviation Capacity Initiatives Report.

Project 024–110: Aviation System Capacity Planning



025–110 National Simulation Capability (NSC)

Purpose: The NSC will aid and support the R,E&D and systems engineering missions of the FAA by integrating the various R,E&D program elements across the NAS environment. The capability to integrate future ATC subsystems during the conceptual stage of a project permits early requirements validation, problem identification, solution development for those problems, and system capability demonstrations. It permits early injection of human factors and system user inputs in the concept formulation process. The net result is reduced risk in developing products for the National Airspace System, faster infusion of new technology, early acceptance of new NAS concepts by system users, and greater efficiency in performing the R,E&D and systems engineering missions.

Approach: The NSC will be a unique capability because it will not exist in any one place but will be achieved by linking together, on a distributed interactive network, existing simulation capabilities. That capability will allow the FAA to horizontally integrate components of future ATC systems and assess their suitability and capability before production investment decisions are made. Horizontal integration will bring together diverse system components such as terminal automation, en route automation, oceanic control, aircraft flight management systems, and mixes of

aircraft types and performance in a flexible, interchangeable, and dynamic simulation environment. The NSC will permit evaluating new operational concepts, human interfaces, and failure modes in a realistic, real-time interactive ATC environment capable of simulating new or modified systems at forecast traffic levels. Simulation capabilities will be expanded by interfacing with various remote research centers that possess nationally unique facilities and expertise.

Related Projects: All major operational subsystems.

Products:

- NSC Operating Plan
- NSC documentation including: configuration management plan, software development plan, and coding standards
- Experimentation plans and reports
- Air traffic control simulation protocol

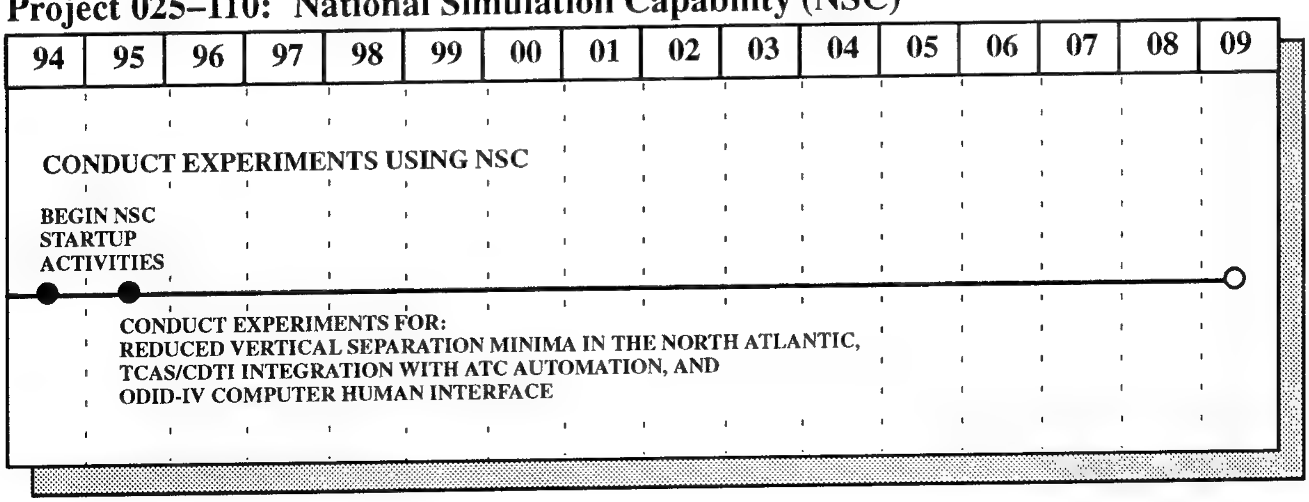
1995 Accomplishments:

- Complete verification, validation, and accreditation methodology for the NSC.
- Complete the NSC Concept of Operations.
- Complete the following experiments: reduced vertical separation minima for the North Atlantic, TCAS/cockpit display of surface traffic information (CDTI) integration with emerging ATC automation, integrated automation components in the Automation Strategic Plan, and operational display and input development (ODID)-IV computer human interface study.

Planned Activities: NSC will continue to support developing expanded experimentation capability at both the integration and interaction laboratory and the FAA Technical Center that will be responsive to FAA sponsor organization requirements. New experiments will be conducted that take full advantage of the additional NSC functionality.

As more issues are identified, experiments will be developed and conducted in the NSC during the out years.

Project 025–110: National Simulation Capability (NSC)



025–130 Air Traffic Models and Evaluation Tools

Purpose: This project will produce modeling and analytic tools to support operational improvements, airspace and airport design, environmental analysis, investment decisionmaking, and ATC system design analysis. The products from this project will provide ATC with the ability to plan, evaluate, and update operational changes rapidly to accommodate the more dynamic airport/airspace environment. This project's models will respond to the dynamic changes resulting from satellite navigation and increased ATC and cockpit automation. The program will emphasize improvements to existing models and new model developments that produce the highest payoff. Modeling products will be improved to make them simpler, faster, more effective, and more widely used and accepted.

Approach: Development will focus on integrated airport and airspace modeling. Previously developed models, such as National Airspace System performance analysis capability (NASPAC) and the FAA's airport and airspace simulation model (SIMMOD), will be made easier, faster, and more flexible to use. New model variants will enable clients to make fast approximations to complex situations. SIMMOD, an FAA trademark software program, is used by the FAA, industry, and foreign governments to design airport layouts and airspace routings.

The sector design analysis tool (SDAT) aids in redesigning en route airspace to increase capacity and balance the controller workload. SDAT derivatives are the terminal airspace sector design analysis tool (T-SDAT) and the national airspace sector design analysis tool (N-SDAT) that provide new capabilities for evaluating terminal and multicenter en route airspace design. Additionally, a critical sector detector (CSD) will be developed to determine when airspace sectors will reach critical traffic density levels based on controller workload limits.

Related Projects: 021–110 Advanced Traffic Management System (ATMS)/Operational Traffic Flow Planning (OTFP), 021–220 Multiple Runway Procedures Development, 024–110 Aviation System Capacity Planning, and 025–110 National Simulation Capability (NSC).

Products:

- Enhanced SIMMOD airport and airspace simulation model
- SIMMOD/SDAT/NASPAC capabilities installed in ARTCC's, TRACON's, and FAA regional offices
- NASPAC U.S. airspace simulation production model
- SDAT, T-SDAT, and N-SDAT
- Critical sector detector

1995 Accomplishments:

- Establish SIMMOD tool at three more FAA sites for a total of nine.
- Implement N-SDAT at ARTCC's.
- Release initial NASPAC production model version.

Planned Activities: New SIMMOD logic enhancements will increase simulated traffic dynamic control and account for en route system dislocations. In 1996, a new SIMMOD, version 3, will be released to accommodate future airspace requirements for user-preferred direct routing. In 1997, version 3.1 with controller communications modeling capability will be released. This project will provide SIMMOD

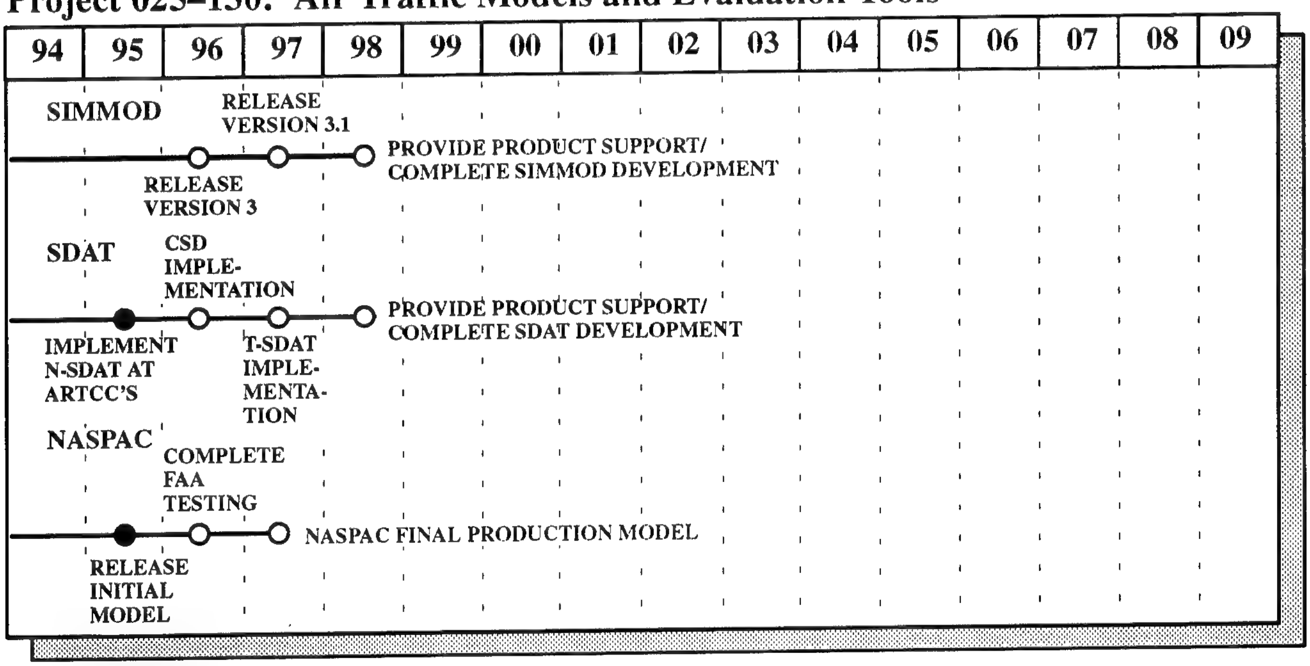
product support through 1998 to complete SIMMOD development.

In 1996, work will continue on SDAT derivatives. Also in 1996, CSD development work and implementation will be completed. T-SDAT testing of controller workload algorithms will be conducted in 1996, with completion/implementation expected in 1997. Product support will be provided through 1998 when SDAT development will be completed.

In 1996, work will continue on NASPAC to develop a user-friendly workstation production version. The current NASPAC version is a prototype developed by MITRE that considers various performance measures for determining NAS-wide impacts from proposed system improvements. The production model will permit analysts to conduct studies more easily and quickly, and will provide more sensitivity to proposed changes in the overall airspace system design. NASPAC testing will be conducted at the FAA Technical Center through 1996, with implementation expected in 1997.

In 1996, the integrated analysis environment model will be developed to incorporate a cost/benefit analysis module that automatically assesses monetary impact and supports the system analysis function for SIMMOD, NASPAC, and SDAT.

Project 025–130: Air Traffic Models and Evaluation Tools



025–140 System Performance and Investment Analysis

Purpose: Currently, the FAA has an incomplete capability for determining what R,E&D investments are needed to produce early benefits for the aviation community. An analysis capability is needed to more fully understand present and future problems in the context of the overall ATM system. Each individual R,E&D project has a narrow focus in an attempt to solve a

specific issue or problem. This project will analyze individual R,E&D projects to determine their NAS impact from a broad perspective. Information and data from this research will be used to help guide planning for R,E&D investments. For example, this project will anticipate: airport, airspace, airway facility, and other needs for improving operating efficiencies, as well as minimizing noise and safety concerns.

Approach: This project will apply models and analysis tools to develop the operational NAS baselines, conduct analyses, and provide the quantitative findings necessary for supporting/guiding R,E&D program investment decisions. State-of-the-art operations research methodologies will be used to study the dynamics and interrelationships of the NAS to define those new technologies/concepts that will have the greatest value for the aviation community. These methodologies include using mathematical models, simulations, statistical analyses, and cost/benefit analyses. This project will use the latest aviation community tools available to the FAA, other government agencies, the private sector, and academia. In particular, this project will use models and tools developed by project 025–130, Air Traffic Models and Evaluation Tools. The hallmark of this analysis capability is to provide proactive and timely findings to help resolve critical R,E&D issues. This project will work closely with other organizations, such as Air Traffic and System Capacity, to complement other R,E&D projects and facilitate information transfer.

Related Projects: 021–110 Advanced Traffic Management System (ATMS)/Operational Traffic Flow Planning (OTFP), 024–110 Aviation System Capacity Planning, 025–110 National Simulation Capability (NSC), and 025–130 Air Traffic Models and Evaluation Tools.

Products:

- Program plan
- NAS performance baselines
- Reports/findings on current and future NAS performance
- Reports on airspace and airport operational analyses
- Reports/findings on R,E&D project NAS operational effectiveness
- R,E&D project cost/benefit analyses

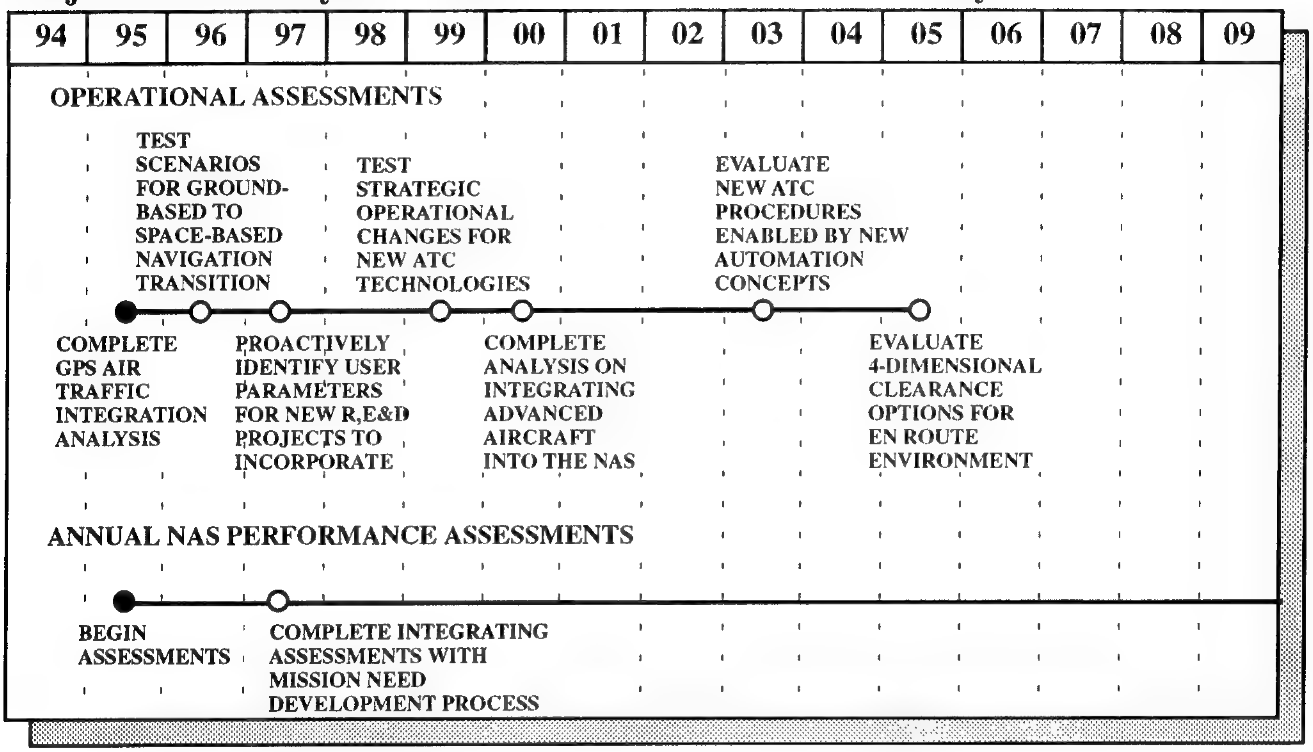
1995 Accomplishments:

- Complete report detailing present and future NAS performance levels.
- Complete two reports with findings on using GPS for more efficient routing in the NAS.
- Complete report with findings on NAS operational effectiveness for the CTAS.
- Complete report on NAS impacts of preliminary scenarios for transitioning from ground to satellite-based navigation systems.

Planned Activities: A key product of this project is a yearly NAS performance assessment. The assessment's objective is to maintain an up-to-date NAS performance appraisal used to construct guidance for new R,E&D projects. In 1996 and beyond, this project will broaden the operational focus of the analyses to include airway facilities, system capacity, and flight standards issues. In 1996, the project will provide findings on the best scenario for transitioning from ground-based navigation systems to satellite-based systems. In 1997, operational assessments will be conducted to proactively identify user parameters that new R,E&D projects will incorporate. These parameters will ensure that R,E&D projects are sensitive to the aviation industry's economic health. Also in 1997, NAS performance assessments will be integrated with the R,E&D mission need development process.

In 1998 and beyond, operational assessments will identify critical operational changes that may be required to realize maximum benefits from new R,E&D projects. In 1999, strategic operational changes for new ATC technologies will be tested and the findings delivered to appropriate agencies. In 2000, an analysis will be completed on integrating advanced aircraft into the NAS. Examples of these new aircraft are the high-speed civil transport and 600–800 passenger ultra-large aircraft. In 2003, this project will evaluate new ATC procedures resulting from new automation concepts for strategic air traffic management. In 2005, 4-dimensional clearance options will be evaluated for the en route environment. The findings generated by these evaluations will be provided to appropriate regulatory agencies for implementation.

Project 025–140: System Performance and Investment Analysis



026–110 Airway Facilities Future Technologies

Purpose: The traditional Airway Facilities (AF) role is changing dramatically. This change is being driven by new technology, a changing work force, and increasing levels of automated AF system management. While the traditional ways have proven to be effective when replacing a single system or part of a single system, they may be ineffective in the future due to the magnitude and complexity of the planned NAS modernization.

This project will ensure that the transition to the new AF environment will not occur in a vacuum. The current AF organizational structure and assigned functions may not be consistent with achieving projected capabilities from new

systems entering the NAS. Management will need to assess AF organizational configuration in response to many issues. Research must investigate interdependencies for total system and operations integration. Research efforts will assess proposed changes to help guide the FAA in meeting future AF operational needs. This project complements the Airway Facilities Human Factors project by developing the models and evaluation tools to develop appropriate policies and identify alternative organizational functions. A key element will be to examine emerging technologies for applications in the total AF environment.

Approach: First, the project will develop an overall plan for the Airway Facilities R,E&D Program. The plan will specify the guidelines for determining the AF operational, organizational, functional, and technological baselines as well as analyze their mutual interdependencies. In addition, the plan will specify a program implementation process to ensure that research, engineering, and development in each of the areas is integrated, and that the products lead to an overall system to meet AF's future needs.

This project will develop simulation models for developing and assessing alternative concepts and methodologies for future AF operations. Models will be developed through rapid prototyping to evaluate promising operational concepts. Proposed procedures and operational concepts will be tested in simulated operational environments and scenarios. Alternative organizational structures will be developed and modeled for assessment and refinement. Evaluation tools will be provided to measure correlations between operations concepts, organizational structures, functional capabilities, and technological capabilities.

A testbed will be developed to investigate various scenarios associated with new technologies such as remote maintenance monitoring, the Operations Control Center (OCC), and AF interfaces with satellite systems. Expert diagnostic, predictive, and resolution tools (EDPRT) will be developed to support reliability-centered maintenance and to help isolate and solve equipment problems. The testbed will be used to develop requirements and design approaches for the EDPRT tools and to investigate their use in simulated operational environments. Also, applications for an intelligent tutoring system (ITS) will be identified to provide additional interactive tools to increase AF productivity. These tools will be fully integrated into the testbed.

Related Projects: 025–110 National Simulation Capability, 032–110 Satellite Navigation Program, and 083–110 Airway Facilities Maintenance Human Factors. Capital Investment Plan projects: 26–01 Remote Maintenance Monitoring System (RMMS) and 26–04 Maintenance Control Center (MCC).

Products:

- Airway Facilities Research Program Plan
- Airway Facilities system testbed
- Simulated Operations Control Centers
- Airway Facilities certification standards for people and equipment
- Expert diagnostic, predictive, and resolution tools
- Intelligent tutoring systems
- Future Airway Facilities operational concepts

1995 Accomplishments:

- Define AF system testbed architecture.
- Develop OCC simulation prototyping tool.

Planned Activities: In 1996, work will continue on developing the AF testbed. In 1996, test and evaluation capabilities will be completed,

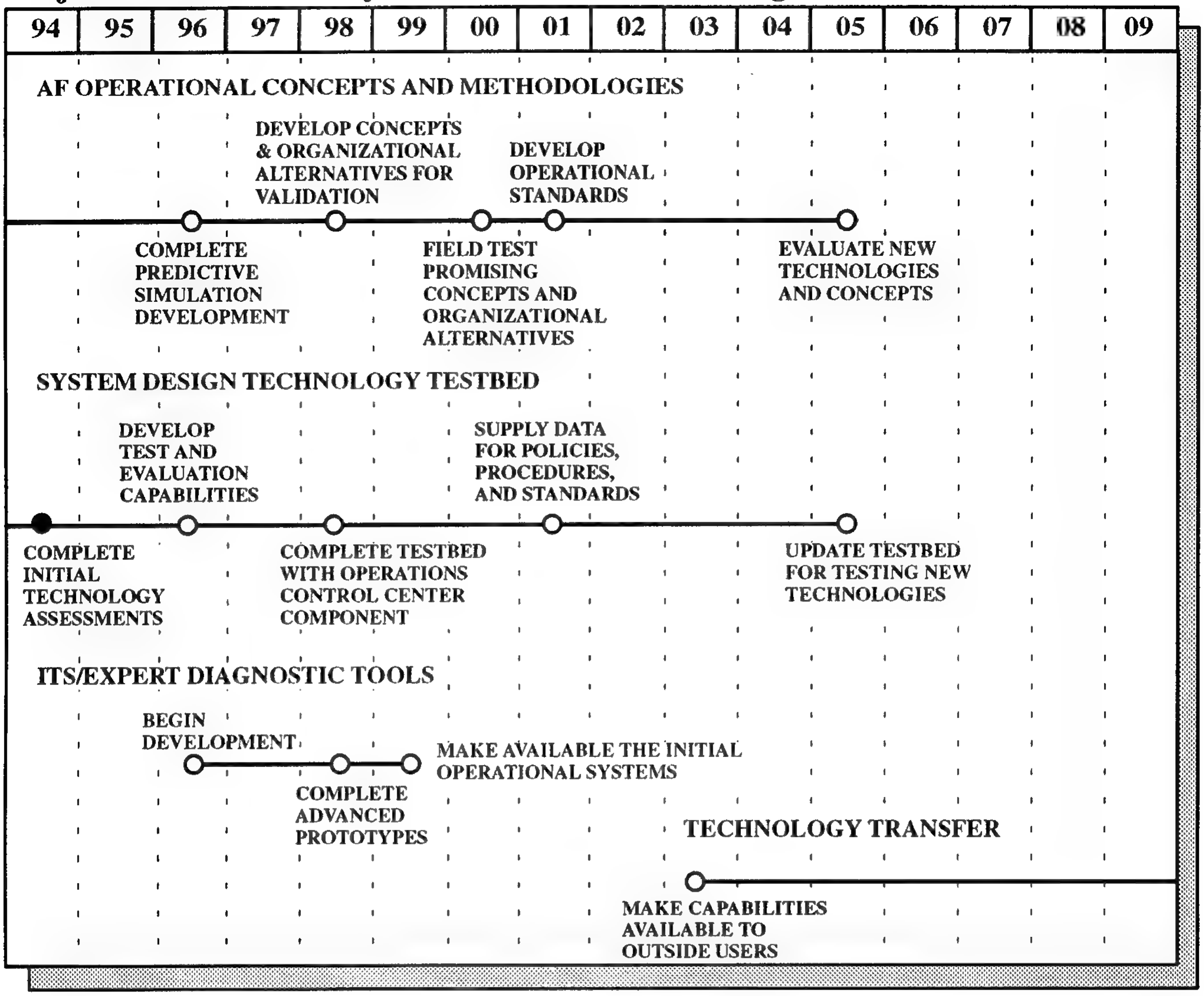
leading to an Operations Control Center component in 1998. Analysis results will be available in 2001 for developing policies, procedures, and standards.

In 1996, development on predictive simulations will be completed to identify organizational alternatives and to simulate future AF system responsibility/functions in the NAS. These tools will be used for research within the Airway Facilities Human Factors project. Additionally, the models and tools will be used in 1996–1997 to develop, evaluate, and validate AF strategies, concepts, and methodologies for modernization within the NAS. The models will also be used to measure performance for allocating functions and evaluating technologies used in systems management. In 1998, promising concepts and methodologies will undergo final validation via field testing at selected locations. This field testing will be completed in 2000, and AF operational standards will be developed in 2001.

In 1996, development will begin on the ITS and the EDPRT's. Advanced prototypes will be completed in 1998 with operational systems available by 1999. Additional ITS/EDPRT development needs will be identified in future years based on future NAS technology.

In the 2002–2010 timeframe, emerging technologies will be tested and evaluated for possible applications to the future NAS infrastructure. In 2003, the modeling, methodology, and testbed capabilities developed by this project will be available for future domestic transportation needs such as high-speed rail, maritime, and intelligent vehicle highway/systems. By 2005, evaluations will take place on emerging technologies and concepts for the AF workforce. These evaluations will continue through 2010. The testbed will be updated as needed to accommodate these evaluations.

Project 026–110: Airway Facilities Future Technologies



3.0 COMMUNICATIONS, NAVIGATION, AND SURVEILLANCE

The air traffic management (ATM) system's ability to support safe and efficient future flight operations is critically dependent on a high-performance, reliable, cost-effective communications, navigation, and surveillance (C/N/S) infrastructure. Because these systems require avionics development and certification, the FAA takes an active role in assessing and defining system requirements, strengths, and characteristics for appropriate integration into the ATM system.

The sensor and computer technology to provide the desired C/N/S infrastructure is an extension of successful commercial and military developments during the 1980's. One key technology is a high capacity air mobile communication system that permits automated communications between the cockpit and the ground computer automation products being developed in Chapter 2. The International Civil Aviation Organization (ICAO) has recognized the need to develop international standards for this capability and has directed the Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel to include this standardization activity in its work program.

Another key technology is applying satellites to ATM. The satellite's role in future C/N/S systems has been highlighted by the Future Air Navigation System (FANS) committee established by ICAO in 1983. The FAA has adopted the FANS recommendation as a basis for its C/N/S research program. This technology offers a number of opportunities to improve C/N/S coverage, accuracy, and reliability. Aircraft users are anticipating sufficient benefits and are aggressively planning to incorporate this technology in future airframe deliveries by developing appropriate interface standards. It is essential that the FAA proactively pursue this technology so that validated standards and certification criteria are available in a responsible timeframe. The Research, Engineering and Development (R,E&D) challenge is to provide this C/N/S infrastructure by the mid-1990's for inclusion in the next generation aircraft.

Enhancements in C/N/S achieved through these R,E&D projects provide the basis for dramatic improvements in system performance including improved safety, reduced delay, increased capacity, and greater efficiency. These three functional areas represent key ATM infrastructure elements. For this reason, many of the quantitative benefits from this area will be realized by implementing projects in the capacity and ATM technology thrust area. For example, the Aeronautical Data Link project, the Satellite Communications project, and the Satellite Navigation project provide the technology necessary to achieve the benefits associated with reducing oceanic separation standards in the Oceanic Air Traffic Control (ATC) Automation program.

Several projects in this thrust area are focused on replacing, at the appropriate time, existing systems with systems that have enhanced capabilities. The future benefits assessment for these projects will only focus on the enhancements' value.

The Department of Defense's (DOD) global positioning system (GPS) deployment, justified by national security requirements, has many civilian applications. The DOD has stated that GPS will be available, at no direct cost, for civilian applications for the next 10 years. Some projects in this thrust area are developing applications based on GPS as the future primary air navigation system. The benefit from these projects will be the ability to forgo using the present very high frequency omnidirectional range (VOR)/distance measuring equipment (DME) network rather than replace the present electronic equipment. Furthermore, the ability to use differential GPS to provide near-Category (CAT)-I landing capabilities could make this service available at virtually all airports.

SUMMARY

It is imperative that the FAA develop an aggressive and coordinated research program to exploit technological capabilities integrated into a safe and efficient ATM system that will satisfy future needs. The emerging C/N/S systems must be integrated with the automation and weather programs to achieve the safe and efficient ATM system that is required.

3.1 Communications, Navigation, and Surveillance Project Descriptions

031–110 Aeronautical Data Link Communications and Applications

Purpose: Efficient airspace use is constrained by communications limitations in the existing air traffic control system. Aeronautical data link (ADL), when combined with advanced ground and air automation systems, will permit evolving toward an advanced air traffic management (ATM) system. The enhanced ATM communications capabilities provided by data link will facilitate improved airspace utilization, delay reduction, and operating expense reduction. This project has two major elements: Communications and Applications.

Approach:

Communications

This project will develop and validate domestic and international data communications standards associated with the Aeronautical Telecommunications Network (ATN) as well as special purpose air/ground data link capabilities such as the GPS squitter. The ATN will be used for both air/ground and ground/ground data communications, for the National Airspace System (NAS), and international aeronautical communications. This project will also provide the technical communications framework for all NAS systems that plan to implement data link services/applications.

Communications protocols for aviation use will be developed, validated, and standardized both nationally and internationally. Domestic standards are being developed with Radio Technical Commission for Aeronautics (RTCA) and international standards with ICAO. ATN standards are currently being validated with industry participation.

A critical effort for this project is investigating the extended use of the GPS squitter, a periodic data link broadcast from a mode select (Mode S) discrete addressable secondary radar system with data link transponder, for delivering GPS-based aircraft position reports. This broadcast automatic dependent surveillance (ADS) concept, when validated, will provide an enabling technology that supports airport surface traffic automation (ASTA) in developing an airport surface surveillance system. Additionally, this technology will serve as a basis for future cockpit traffic information systems, terminal and en route surveillance, and potentially for the traffic alert and collision avoidance system (TCAS) IV airborne collision avoidance system.

Applications

Essential to achieving benefits from ground and airborne automation systems, data link applications must be developed as the enabling technology to permit efficient flight crew to controller communications. This project will develop the operational concepts, software specifications, and interfaces to integrate data link ground and airborne automation systems into the NAS.

Data link services in oceanic, en route, terminal, and tower environments are defined in coordination with the air traffic and aviation user communities. These services are being developed and evaluated by a team that includes air traffic controllers, pilots, and other system users as appropriate. Demonstrations will then be conducted with both ground and airborne system users to validate the overall operational system effectiveness.

Operational benefit assessments for initial and advanced data link applications will use high-fidelity ground and cockpit simulation facilities. The tower ATC services will be evaluated at selected airports in a fully operational environment with participating air carriers. Routine and hazardous weather applications will be demonstrated and evaluated in various simulation and airborne testbed facilities. Weather and aeronautical services such as traffic advisories, digital automatic terminal information service, and GPS squitter applications will be validated using this approach.

Related Projects: 021–140 Oceanic Air Traffic Automation, 021–180 Terminal ATC Automation (TATCA), 021–190 Airport Surface Traffic Automation (ASTA), 022–150 Flight Operations and Air Traffic Management Integration, 025–110 National Simulation Capability, 031–120 Satellite Communications Program, 031–130 NAS Telecommunications for the 21st Century, 041–110 Aviation Weather Analysis and Forecasting, 041–120 Airborne Meteorological Sensors, 042–110 Aeronautical Hazards Research, and 084–110 Flight Deck/ATC System Integration. Capital Investment Plan Projects: 21–12 Advanced Automation System (AAS), 21–13 Automated En Route Air Traffic Control (AERA), 24–12 Mode S, 62–20 Terminal Air Traffic Control Automation (TATCA), 62–21 Airport Surface Traffic Automation (ASTA), 63–05 Aeronautical Data Link Communications and Applications, 63–21 Integrated Terminal Weather System (ITWS), and 63–22 Aviation Weather Products Generator (AWPG).

Products:

- United States and international ATN data communications, GPS squitter, and applications standards
- Operational concepts and specifications for production automation and communication systems that utilize/support data link
- Prototype systems and operational data link service evaluations
- Testbed for ATN development, evaluation, and validation
- Testbeds for developing, evaluating, and demonstrating data link ATC, weather, and flight information services

1995 Accomplishments:

Communications

- Complete GPS squitter surface surveillance functional specification.
- Complete GPS squitter standard.
- Validate ICAO ATN manual.
- Validate GPS squitter for use on airport surface.
- Conduct/support initial flight tests for ATN in domestic and oceanic airspace.

Applications

- Develop functional specification for integrated ATC data link applications.
- Publish operational concepts and minimum operational performance standards (MOPS) for advanced flight information services.
- Conduct operational demonstration for initial data link weather services.
- Implement initial tower data link services.

Planned Activities:

Communications

ICAO standards and recommended practices (SARP's) for Mode-S data link will be published in 1996. Also in 1996, ICAO SARP's for the initial ATN and GPS squitter will be approved. R,E&D activities will continue through 1999 to support developing and validating standards that extend the ATN for international operations and management. ATN research, jointly sponsored by FAA and the industry ATN consortium, will validate the system operations, develop prototype avionics, and develop certification test tools. In 1997, development will be completed on prototype avionics and certification test tools. This effort will lead to a cooperative operational evaluation, including flight tests, that will be completed in 1998. Also in 1998, high frequency (HF) and very high frequency (VHF) data link will be validated to support standards approval in 1999. Between 2000–2005, research will be conducted to develop and apply standards for worldwide ATN operations. Concept validation will take place by 2002 with validated requirements by 2005. Also, by 2005, specifications will be developed for end-state NAS ATN systems. Final worldwide ATN requirements will be developed by 2008 for future ATN implementation.

In 1996, development efforts will continue on air/ground and air/air GPS squitter surveillance applications. Specifications will be developed to use the GPS squitter for surveillance in low to moderate density ATC terminals. In 1997, specifications will be developed to use GPS squitter for surveillance in en route airspace. From 1997–2000, research will be conducted to define cost effective strategies for applying GPS squitter technology in high density terminals. From 2000–2004, prototype systems will be developed and used to validate the GPS squitter application in these terminals followed by a specification in 2005.

Applications

In 1996, research will continue on ATC data link services. In 1997, advanced tower data link services will be developed enabling improvements to the direct predeparture clearance distribution. In 1997, initial terminal data link services will be fielded in larger terminal radar approaches (TRACON's), followed by initial en route data link services in air route traffic control centers (ARTCC's) in 1998. This project will provide transition support for these services through 2000. In 1996, operational procedures development and government/industry data link benefits studies will be completed for integrated data link services. Through 1997, specifications and prototypes will be developed for integrated data link services, with testbed evaluation completed in 1998. Integrated terminal service development will be completed in 1999, followed by integrated en route services in 2000.

In 1998, research will begin on developing advanced terminal and en route data link services. User needs and procedural benefits analyses will take place through 1999, followed by specification development in 2000 and testbed evaluation of prototypes in 2001. Advanced terminal service development will be completed in 2003, followed by advanced en route services in 2004.

In 2001, research will begin on developing advanced automation data link enhancements. Commercial and general aviation experience with data link will be analyzed to produce next generation data link specifications. Using specifications developed by 2005 , prototypes will be developed and evaluated on testbeds by 2006. These advanced automation data link enhancements will be implemented in 2008 through facilities and equipment (F&E) acquisition.

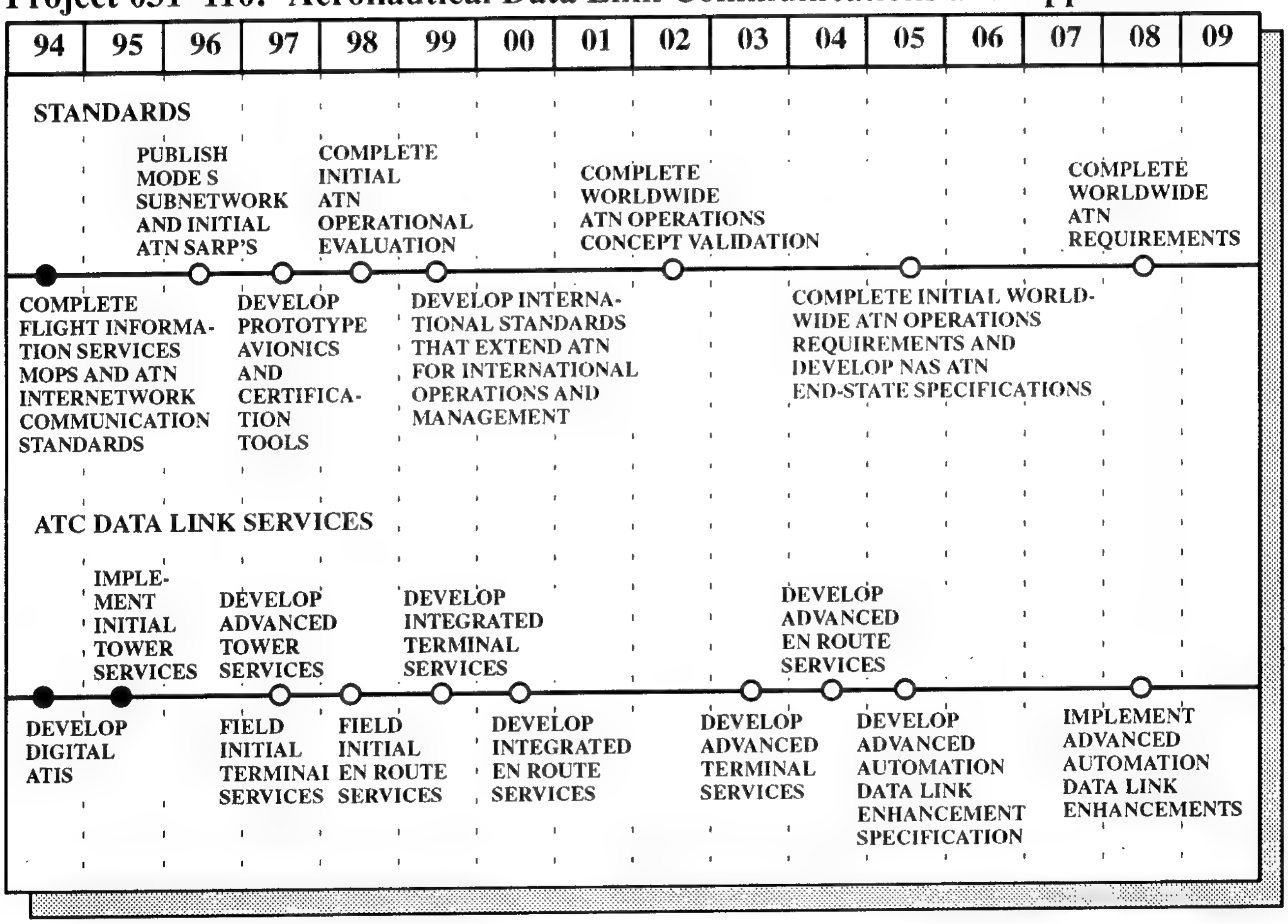
In 1996, research will continue on data link flight information services. Graphical weather services will be developed in 1996, followed by initial

flight information services (FIS) data link implementation in 1997. From 1997–1998, functional specifications will be developed and evaluated for the integrated FIS data link services. Prototypes will be designed and tested, and MOPS will be validated on FIS testbeds by 1999. Development work on integrated data link services will be completed in 2000.

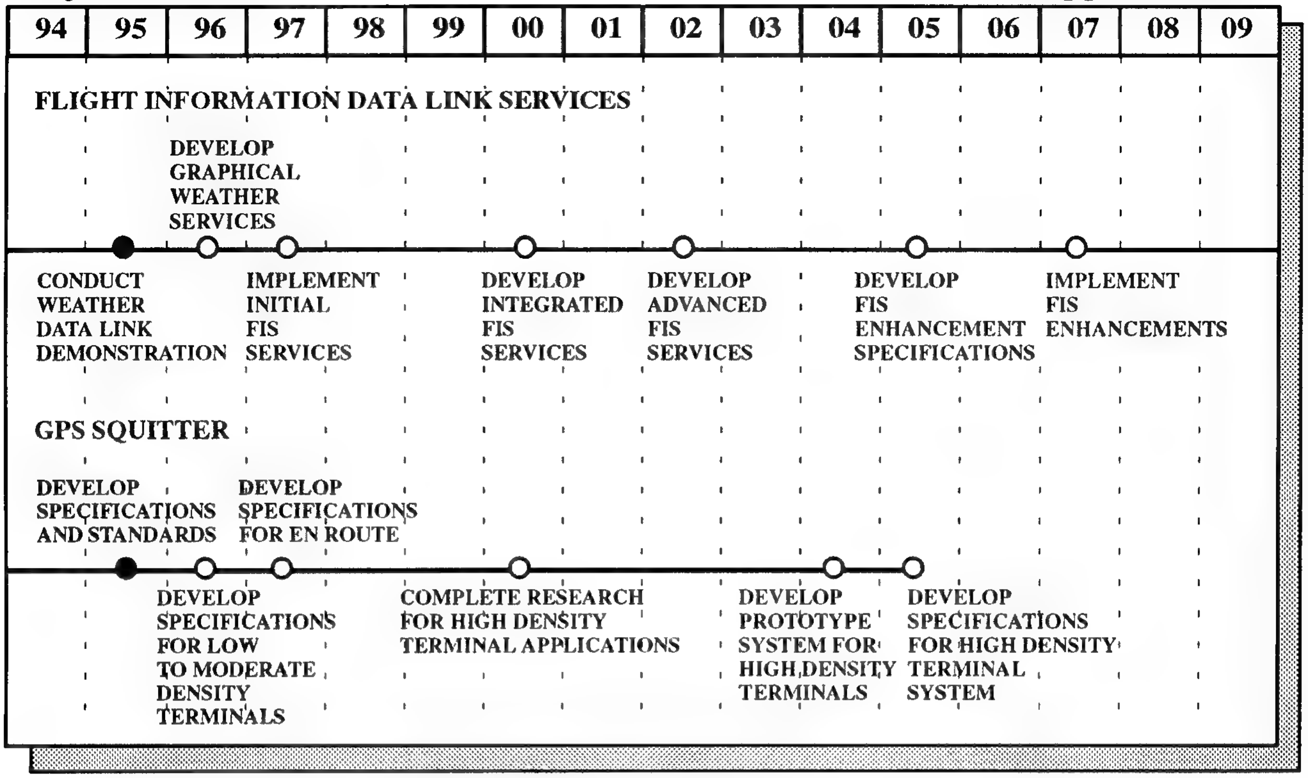
Research and development for the advanced flight information data link services will begin in 1999 with analyses of FAA and industry experiences with previously implemented FIS data links. The analyses results will be used to generate specifications in 2000, and prototypes/evaluation testbeds in 2001. Advanced FIS development work will be completed in 2002.

In coordination with the advanced automation system evolution, research for the FIS data link enhancements will begin by 2003. Specifications will be developed by 2005, with prototyping and evaluation completed by 2006. The implementation of FIS automation enhancements will be completed by F&E acquisition in 2007.

Project 031–110: Aeronautical Data Link Communications and Applications



Project 031–110: Aeronautical Data Link Communications and Applications



031–120 Satellite Communications Program

Purpose: The demand for oceanic airspace capacity is increasing due to an expected 50 percent traffic growth in the North Atlantic and 100 percent in the Pacific by 2000. Current communications are limited to HF voice radio only and are slow, unreliable, poor quality, and capacity constrained. Due to these technical constraints, real-time air traffic control cannot be accomplished in these regions, and transoceanic route capacity cannot be expanded to accommodate the rapidly growing demand. This project will develop the standards and perform required testing to support mobile satellite communication (SATCOM) operational use for civil aviation beginning with oceanic, offshore, and remote regions. Further research will be conducted to extend these capabilities to domestic airspace.

Approach: Three separate R,E&D projects are working together to bring satellite data and voice communications capabilities to oceanic areas. This project is integrated with the Aeronautical Data Link Communications and Applications and the Oceanic Air Traffic Automation projects to achieve increased safety, help reduce separation standards, and provide direct, reliable communications in the oceanic and remote areas. This project is separated into four distinct initiatives:

<u>Developing Satellite Communications Data Capabilities for Oceanic and Remote Regions</u>

The FAA will continue to support the SARP's for implementing satellite data transmission in

oceanic areas. Additionally, support will be provided to RTCA Special Committee 165 to develop MOPS and ensure that the MOPS are consistent with the SARP's.

Flight testing will be completed to validate SARP's and MOPS with commercial airline participation over the North Atlantic in cooperation with European civil aviation authorities. A ground test facility will be used to conduct system end-to-end and radio frequency tests to validate standards not currently validated by manufacturers' data.

Developing Satellite Communications Voice Capabilities for Oceanic and Remote Regions

This initiative is necessary to provide satellite voice capability between the cockpit and the ARTCC in oceanic flight information regions. In conjunction with RTCA, a guidance document will be produced describing the full range of technical requirements to provide satellite voice capability. In coordination with the oceanic project office, an architecture will be developed that will enable controllers to send and receive direct satellite voice communications. This effort includes developing appropriate interfaces for FAA equipment. Flight trials will be conducted with major airlines to demonstrate/evaluate satellite voice capabilities.

Implementing Satellite Communications Services in Oceanic and Remote Regions

This initiative addresses support for the Communications/Surveillance Operational Implementation Team (C/SOIT). This support includes technical expertise, analyses, and technical data. The team is responsible for developing operational regulations and procedures that implement satellite communications. The benefits derived from SATCOM require a combined effort among ATN, ADS, ARTCC automation, and SATCOM. The C/SOIT ensures the joint implementation of these efforts. Technical data will be collected from bilateral and multilateral engineering trials. This effort will integrate real-time end-to-end communications and communication emulation capabilities into the Oceanic Development Facility.

Developing Satellite Communications Services for Selected Domestic Applications

The currently defined oceanic aeronautical mobile satellite services (AMSS) system may have applications in domestic areas. For example, offshore or mountainous regions where very high frequency does not penetrate could benefit from AMSS service. It is also possible that emerging SATCOM technology, including possible Low Earth Orbiting or Medium Earth Orbiting systems, can provide reliable and efficient data/voice capability that meets domestic requirements at a reasonable cost. This project will conduct feasibility studies and evaluations on lower cost, lightweight satellite communications avionics for general aviation and rotorcraft. Additionally, analysis is underway to determine architecture requirements for future SATCOM use.

Related Projects: 021–140 Oceanic Air Traffic Automation, 023–120 Separation Standards, 031–110 Aeronautical Data Link Communications and Applications, and 032–110 Satellite Navigation Program. Capital Investment Plan projects: 61–22 ATC Applications of Automatic Dependent Surveillance (ADS) and 63–05 Aeronautical Data Link Communications and Applications.

Products:

- International AMSS SARP's with ICAO
- MOPS for AMSS avionics with RTCA
- AMSS voice communications architecture
- Integrated ATN/AMSS model capable of testing end-to-end data communications

1995 Accomplishments:

- Conduct engineering trials with manufacturers' prototypes for satellite communications voice capabilities in oceanic and remote regions.
- Publish RTCA MOPS for SATCOM voice capability.
- Flight test ATN-compatible SATCOM prototype avionics system.

Planned Activities:

Developing Satellite Communications Data Capabilities for Oceanic and Remote Regions

In 1998, ICAO AMSS MOPS and SARP's verification will be completed. Data collected during operational tests will be used in industry avionics bench testing for SARP's compliance certification and ICAO approval in 1998. The AMSS SARP's approval completes the R,E&D effort for this initiative.

Developing Satellite Communications Voice Capabilities for Oceanic and Remote Regions

In 1996, architecture provisions based on RTCA MOPS for SATCOM voice avionics will be completed for ground interfaces with FAA equipment. This work will complete R,E&D efforts for this initiative.

Implementing Satellite Communications Services in Oceanic and Remote Regions

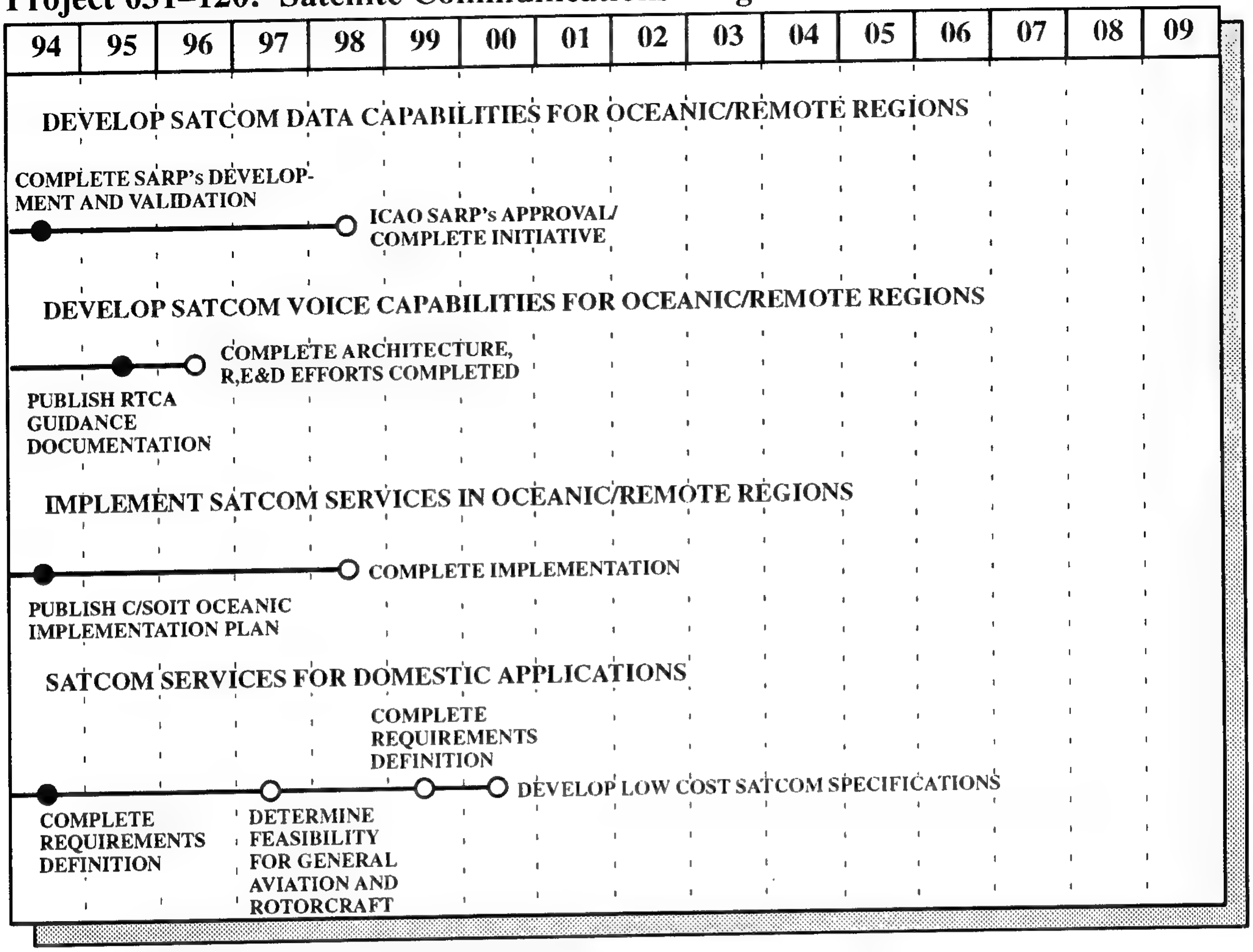
In 1996, data collection and analysis will continue from the North Atlantic engineering trials. Recommendations based on the data will be provided to the C/SOIT for regulatory and procedural implementation guidance. The C/SOIT plan specifies an incremental oceanic SATCOM implementation program that will be completed by 1998.

Developing Satellite Communications Services for Selected Domestic Applications

In 1997, a feasibility determination will be completed on lower cost, lightweight SATCOM avionics for general aviation and rotorcraft. From 1997–2000, a field evaluation using multiple, vendor-supplied prototypes will be conducted, leading to a specification for commercial off-the-shelf (COTS) low-cost SATCOM avionics in 2000.

In 1997, further research based on the alternative SATCOM technology requirements definition will continue on long-term alternatives for providing SATCOM service in domestic areas. Anticipated completion for this effort is expected in 1999.

Project 031–120: Satellite Communications Program



031–130 NAS Telecommunications for the 21st Century

Purpose: This project supports the next generation NAS communications system development by evaluating alternatives in new communication technology to satisfy future operational NAS requirements and goals. This effort is a multiyear project that is intended to speed the introduction of new technology into the NAS communications system. The current priority is to improve the air/ground (A/G) and ground/ground communication systems.

A key shortfall in the current VHF A/G system is the lack of capacity to accommodate increasing traffic load. Competition for additional frequency spectrum is intense and will constrain internationally allocated VHF frequencies. Expanding VHF system capacity will require new VHF radios for both the FAA and user communities. Another key shortfall in A/G communications is the oceanic HF analog communications system which is characterized by unreliable performance. Satellite communications capabilities are expected to provide improvements in oceanic areas over analog HF in the near future for new aircraft. This project addresses the older aircraft that will be in operation in oceanic areas for the

next 10 to 15 years and cannot be economically retrofitted with satellite communications equipment. These older aircraft will have their current HF radios modified to add digital HF capability.

Airway Facilities is experiencing shortfalls in ground/ground communications capacity and reliability for interfacility and operational requirements. This shortfall will increase as Airway Facilities implements its new centralized command and control concept of operations unless new technology is developed that addresses the shortfall. The new concept of operations is further expanded in project 026–110, Airway Facilities Future Technologies.

Approach: This project is separated into three distinct initiatives: Digital VHF Voice and Data System; Digital HF Data System; and Airway Facilities Assured Communications.

Digital VHF Voice and Data System

This project will demonstrate how new technology will benefit the next generation NAS communications system. Overall objectives include: focusing R,E&D funding on leveraging new technology; reducing communication system cost; and adhering to a disciplined system engineering approach.

New technologies will be explored to quantify their performance in meeting NAS capacity and reliability requirements. Key factors to consider are: using commercial equipment whenever possible; streamlining operations; developing a transition plan; and integrating with other NAS elements. A cost/benefit study will be completed for each potential technology, and a trade-off analysis will be performed among alternatives.

Air/ground VHF digital voice and data communication system requirements, operational concepts, system design, and appropriate standards will be developed. Technology transfer efforts will be initiated to facilitate industry participation in system development. Furthermore, high risk system elements will be thoroughly prototyped and tested. Challenges this project will face during system development include: accommodating evolving national and international communication standards and applying global addressing, routing, and network management technologies.

Digital HF Data System

The airline industry has been supporting an Aeronautical Electronics Engineering Committee (AEEC) activity for HF data units and HF data radio. An HF data unit is a specialized modem added to an existing HF analog radio providing data capability in addition to analog communications. An HF data radio replaces an existing HF analog radio with a dual-mode radio that has better HF analog performance and the equivalent data capability provided by an HF data unit. The FAA and RTCA will develop MOPS and international SARP's for certifying future HF data communications equipment. Prototypes, trials, and demonstrations will be conducted in conjunction with private industry and international organizations. The project will progress from concept demonstrations through validation, field engineering trials, and architecture/implementation planning.

Digital HF implementation serves aircraft with and without satellite communications equipment. For satellite communications-equipped aircraft, the digital HF functionality adds an independent path and communications reliability improvement considerably greater than the analog HF-only alternative. For aircraft without satellite communications, digital HF implementation provides the opportunity to achieve a full digital-based oceanic communications/operations environment sooner than waiting for older aircraft to be retired. This means that oceanic separation standards can be reduced sooner and easier than in a mixed analog/digital environment.

Airway Facilities Assured Communications

This project will define Airway Facilities' requirements for future fixed and mobile ground/ground communications capabilities. A key element of this project is developing the required architecture to integrate data and voice communications and communication networks. Existing voice/data capabilities and networks are: leased interfacility communications system, radio communications link, and Federal Telecommunications System 2000 voice/data communications; national radio communications system network; and recovery communications network.

Alternative architectures this project will explore are using: air traffic communications capabilities and developing specific capabilities to correct shortfalls; integrated satellite networks; FAA or leased microwave network; commercially available wireless networks; international ground/ground communications; or some combination of all these alternatives. The fixed communications capabilities will support remote maintenance monitoring, maintenance management systems, and operations control center functions. The mobile communications capabilities will support operational dispatch and redirecting systems specialists. Security and performance analyses will be conducted to identify threats from natural, inadvertent, and malicious causes. Alternative concepts will be developed to provide the required capability that minimizes the effect from these threats.

Related Projects: 021–140 Oceanic Air Traffic Automation, 026–110 Airway Facilities Future Technologies, 031–110 Aeronautical Data Link Communications and Applications, and 031–120 Satellite Communications Program. Capital Investment Plan projects: 21–05 Oceanic Display and Planning System (ODAPS), 23–05 Aeronautical Data Link, 46–28 National Airspace System (NAS) Recovery Communication, 56–15 NAS Spectrum Engineering Sustained Support, and 61–23 Oceanic Automation Program (OAP).

Products:

- Internationally compatible requirements and standards for a new VHF and HF air/ground communication system
- Operational concept document for the new VHF communications system and oceanic communication systems
- New VHF and HF communication system design specifications
- New VHF and HF communication system prototype, including flight demonstrations
- Performance specifications for F&E handoff to solicit request for proposal (RFP) for system procurement
- Airway Facilities integrated voice and data communications network architecture

1995 Accomplishments:

- Complete flight testing on a prototype VHF radio system.
- Develop U.S. position on VHF spectrum utilization for ICAO Communications/Navigation/Surveillance division meeting.
- Complete ATN interface for new VHF radio.
- Provide FAA input to complete AEEC form, fit, and function characteristics for HF data units and HF data radio.

Planned Activities:

Digital VHF Voice and Data System

In 1996, work will continue on developing a digital VHF voice and data system. SARP's will be developed in 1997 for production equipment certification followed by F&E program handoff in 1998 for initial system installations. A transitional support program will continue through 2000 to complete this effort.

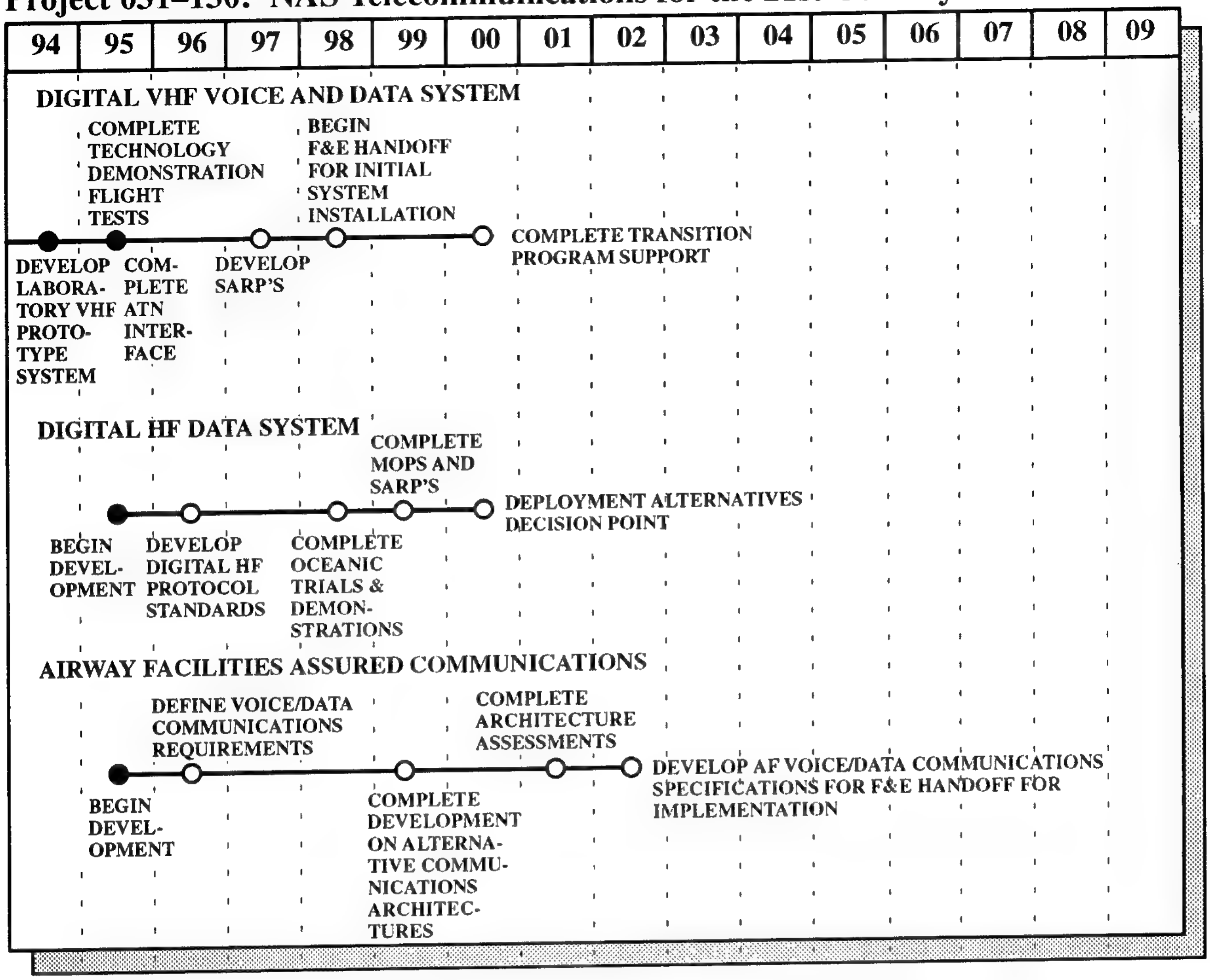
Digital HF Data System

In 1996, current technology and industry plans for avionics will be reviewed and synthesized into specific system concept, communication architecture, and protocol standards. Work on MOPS and SARP's for a digital HF data system will take place from 1996 through 1999. By 1997, HF data unit and HF data radio prototypes will be developed and ready for flight testing. In 1997–1998 oceanic trials and demonstrations will be conducted in conjunction with other oceanic trials and demonstrations such as ADS, two-way satellite communications data link, and oceanic automation systems. The prototype development and engineering trials will be used to support MOPS and SARP's for digital HF data systems. The FAA will reach a decision point in 2000 for implementing digital HF radio, when the FAA will either provide digital HF radio services or utilize industry service providers in accordance with FAA-approved standards.

Airway Facilities Assured Communications

In 1996, requirements will be defined and used for developing specifications on fixed and mobile integrated voice/data communications. In 1997, required performance capabilities for communications reliability will be defined. Also, threat analyses will be conducted from 1996 through 1998. In 1998, the specifications, required performance capabilities, and threat analyses results will be used to develop the alternative communications architectures. Development work on the alternatives will be completed in 1999. Developmental assessments and evaluations will take place through 2001 to select a final architecture and develop Airway Facilities (AF) voice/data communications specifications for F&E handoff in 2002 with final implementation expected by 2010.

Project 031–130: NAS Telecommunications for the 21st Century



032–110 Satellite Navigation Program

Purpose: This project will develop augmentations to navigation satellites (e.g., GPS) to support techniques, procedures, and standards to meet all civil aviation navigation needs using a single navigation receiver. Civil aviation navigation needs include oceanic, en route, and terminal navigation as well as non-precision approach, precision approach, auto-landing, and airport surface navigation. Satellite navigation presents opportunities for standardized worldwide civil aviation operations using a common navigation receiver and for significant improvements in safety, capacity, service flexibility, and operating costs. Adopting satellite navigation systems could lead to phasing out existing National Airspace System ground equipment while maintaining or improving existing service levels. In addition, satellite-based navigation systems provide the potential for new navigation and landing services not currently supported by existing systems.

Approach: This project will focus on developing standards and methods to use the global positioning system to meet civil aviation requirements. Project activities will investigate GPS augmented for required navigation performance (RNP) for en route, airport surface, departure, and precision approach applications, including curved and missed approach guidance. The RNP is an internationally defined measure of a navigation system's performance within a defined airspace, including current navigation system operating parameters within that airspace. GPS augmented for RNP will constitute a "standalone" configuration with required redundancy. The overall program will be supported by establishing a Satellite Navigation Testbed at the FAA Technical Center. The testbed will be used to verify theoretical analyses, collect data in a realistic environment, simulate "worst case" scenarios, and provide a means to analyze performance data.

The Satellite Navigation program will be structured with four interrelated and complementary thrusts. These will focus on the Civil Aviation Service, operational implementation of the service, international activities, and related programs.

Related Projects: 021–140 Oceanic Air Traffic Automation and 021–190 Airport Surface Traffic Automation (ASTA). Capital Investment Plan projects: 61–22 ATC Applications of Automatic Dependent Surveillance (ADS) and 62–21 Airport Surface Traffic Automation (ASTA).

Products:

- Satellite-based instrument approach procedures
- MOPS for GPS supplemental use in the NAS
- Augmentation requirements for GPS to meet civil aviation RNP
- MOPS for avionics to meet RNP
- Minimum avionic system performance standards for special use CAT I

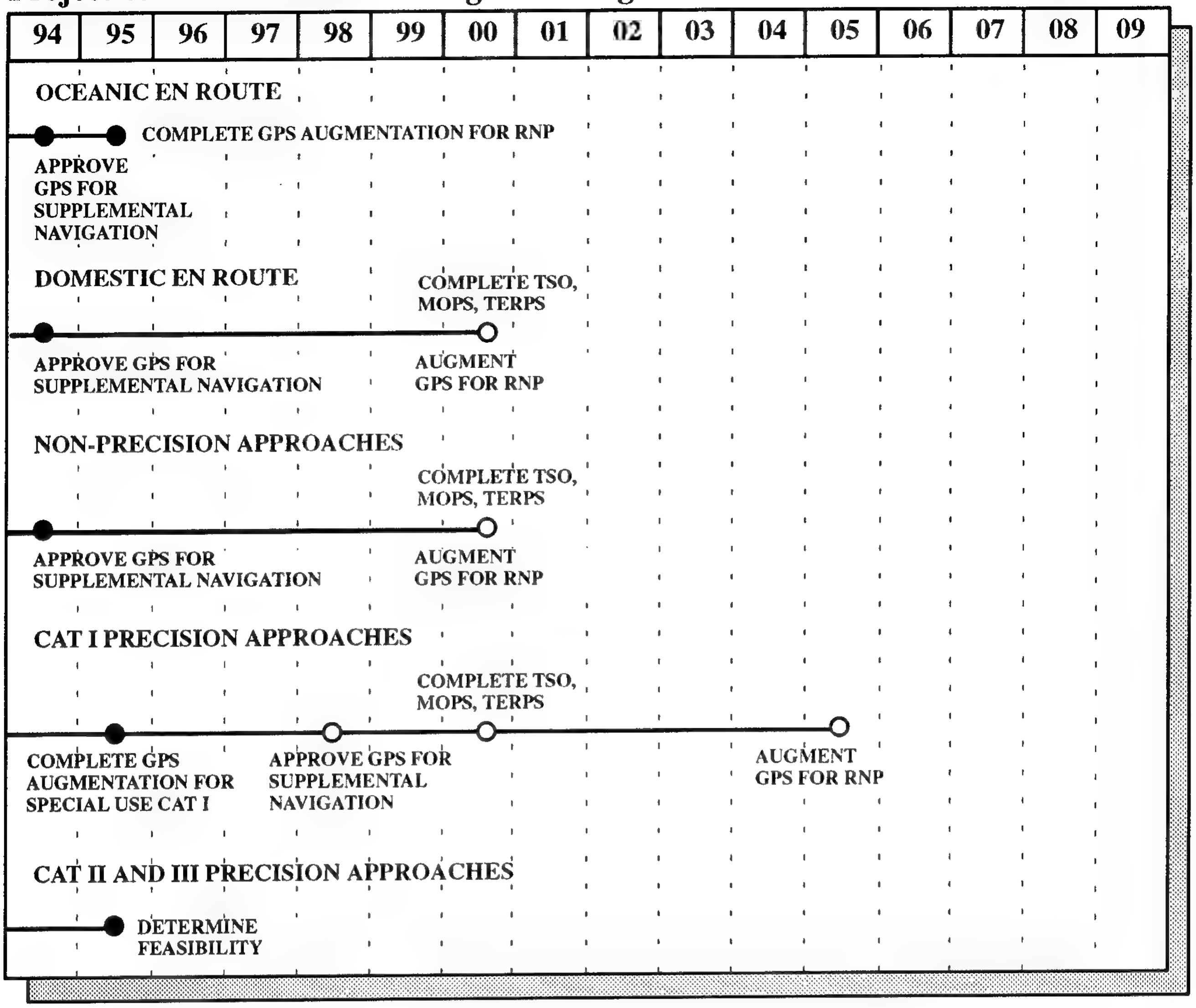
1995 Accomplishments:

- Complete GPS augmentation for RNP to support oceanic en route operations.
- Determine feasibility of CAT II/III precision approaches.
- Complete GPS augmentation for special CAT I precision approaches.

Planned Activities: In 1996, research will continue on developing standards and operational procedures development to permit early satellite navigation system implementation for civil aviation. This research will culminate in technical standard orders (TSO), MOPS, and terminal instrument procedures (TERPS) in 2000 for en route through CAT I precision approaches.

GPS supplemental precision approaches to CAT I will be approved for public use in 1998, with RNP scheduled for 2005. In 2000, GPS augmented for RNP will be implemented in domestic en route airspace.

Project 032–110: Satellite Navigation Program



032–120 Navigation Systems Development

Purpose: The FAA has the responsibility for developing and implementing radionavigation systems to meet the needs of all civil and military aviation, except those peculiar to air warfare. This project, in an integrated effort with other R,E&D projects, addresses transitioning to a satellite-based navigation system and developing the strategy for decommissioning older-technology ground-based systems. An important aspect is identifying and evaluating emerging technologies and new concepts for meeting future navigation service requirements.

Navigation Systems Development also supports the Federal Radionavigation Plan (FRP) biennial revision and provides the FAA input to the joint Department of Transportation and DOD Radionavigation Working Group.

Approach: This project's emphasis is to support developing a NAS transition strategy that will provide guidance for a major shift to satellite technology. Research will focus on resolving three major issues: current navigation system supportability; transition to satellite-based navigation; and potential ground-based systems phaseout.

Until a transition to satellite systems is completed, research will continue on current ground-based system supportability issues. An assessment will be conducted to identify potential operating cost reductions, performance enhancements, or new function additions to navigation aids now operated by the FAA. Available technology will be identified and the potential to enhance navigation aids will be examined. Algorithms for enhancements will be developed and applied in laboratory simulations to test their effectiveness. An example is improving the VOR antenna system to reduce sensitivity to the site environment.

Studies and analyses will be performed to help complete development of the RNP concept for satellite-based final approach and landing operations. The results from these efforts will be used to develop recommendations on the RNP criteria. The recommendations will be provided to the ICAO All Weather Operations Panel, the Satellite Operational Implementation Team, and RTCA special committees for incorporation into appropriate standards.

Supplemental studies and analyses will be performed to support developing the FRP. Based on the research results, recommendations will be made on the appropriate system mix to be included in the FRP. A national aviation standard will be prepared and maintained for each system approved for use in the NAS.

Related Projects: 021–140 Oceanic Air Traffic Automation, 023–120 Separation Standards, and 032–110 Satellite Navigation Program. Capital Investment Plan projects: 61–22 ATC Applications of Automatic Dependent Surveillance (ADS) and 64–05 Augmentation for GPS.

Products:

- Navigation and landing transition strategy for the FAA National GPS/CNS Transition Plan
- Reports on enhancing performance and reducing costs of existing ground navigation systems
- GPS Notice to Airmen (NOTAM) capability
- National aviation standards for radionavigation systems
- Recommendation for the NAS system mix
- Biennial FRP publication

1995 Accomplishments:

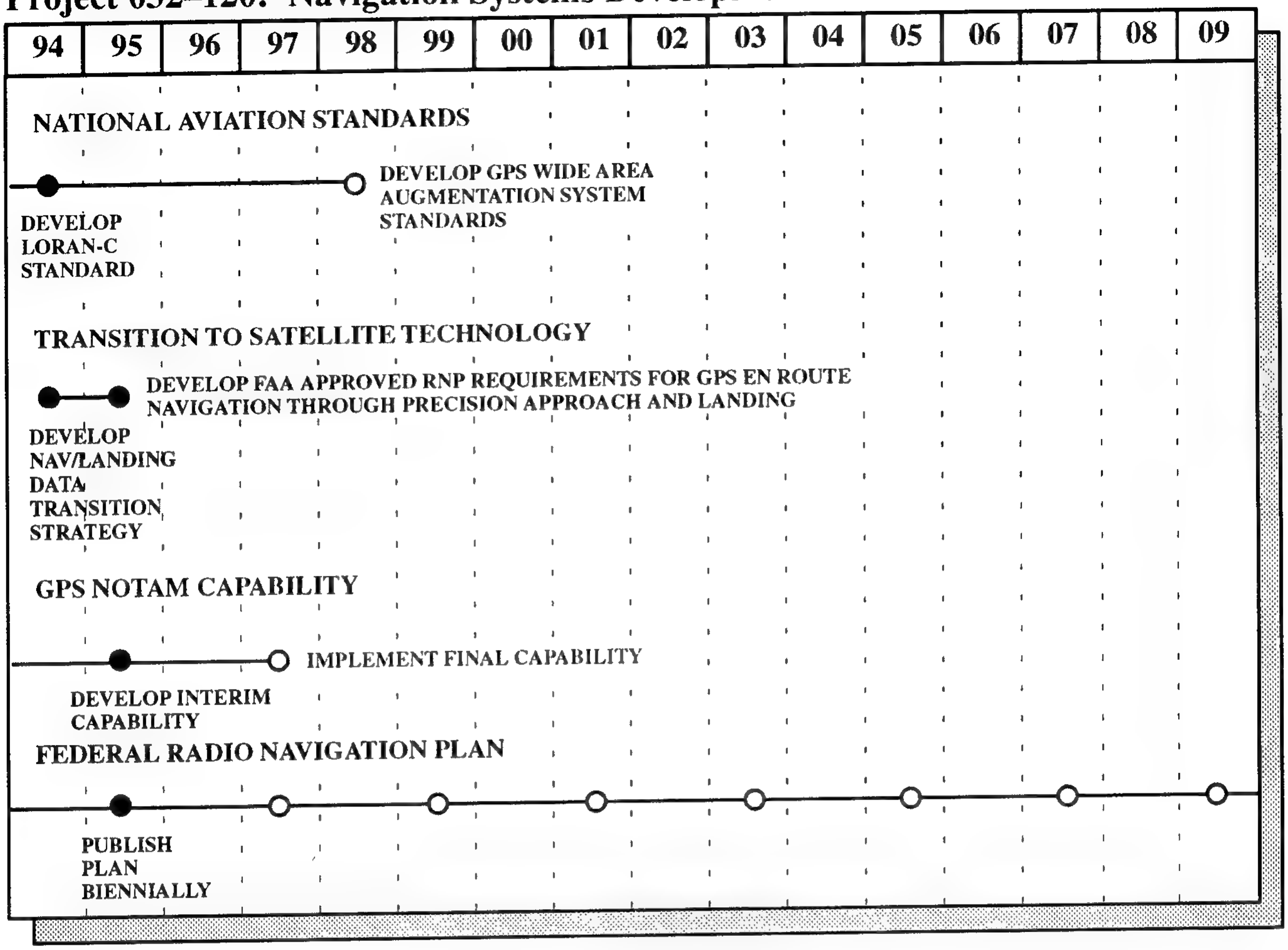
- Develop RNP requirements for en route navigation through precision approach and landing.
- Develop recommendations on VOR/DME, nondirectional radio beacons, Omega, and Long-Range Navigation (Loran)-C replacement and sustainment.

Planned Activities: In 1998, national aviation standards will be developed for the GPS wide area augmentation system. These standards will be used by manufacturers to develop technical standard order approved equipment.

In 1996, the next edition of the Federal Radionavigation Plan will be published. The Plan is published on a biennial basis.

A final GPS NOTAM capability will be implemented in 1997 to support GPS RNP requirements.

Project 032–120: Navigation Systems Development



033–110 Terminal Area Surveillance System

Purpose: The next generation terminal area surveillance system must support a requirement for improved aircraft and weather detection capabilities as well as support features such as closely spaced runway approaches. Emerging technology will allow the FAA to meet these requirements and improve on operational performance limitations imposed by today's technology. This project will develop the next generation terminal surveillance system by: defining system requirements; determining future operational concepts; assessing emerging technology applicability, benefits, and risks; and developing advanced capabilities in weather and aircraft detection. The system must have an ability to detect dry microbursts at useful ranges; measure wind fields for wake vortex prediction; detect ice, water, hail, and tornadoes; and support aircraft surveillance operations with seamless coverage and flexible routing tailored to the specific terminal site.

Approach: System delays and separation criteria will be reduced through more timely and accurate aircraft detection and improved weather detection capabilities. There will be a strong emphasis on rapidly updating the 3-dimensional weather and aircraft display for controllers.

Operations research analysis and simulations will be used to assess and identify practical airspace safety and capacity-enhancing features in emerging technology. The FAA and industry will assess these technologies, evaluate potential performance against the terminal area sensor primary and secondary surveillance and weather requirements, and assess technical and operational risks.

The new terminal surveillance system will use a modular architecture to provide for site adaptation and upgrade at minimal cost. A possible option is to combine current airport surveillance radars, terminal Doppler weather radars, and low-level windshear alert systems into a single, high data rate, multi-function radar. This option will depend on the potential cost savings balanced against the additional program risk that may be incurred.

Concept development analysis and technology demonstration experiments are being conducted as parallel activities to reduce the potential risk of future development. The results from these experiments will lead to multiple selections for prototype development and testing.

Related Projects: 021–230 Wake Vortex Separation Standards and 041–110 Aviation Weather Analysis and Forecasting. Capital Investment Plan projects: 24–12 Mode S, 24–13 Terminal Radar (ASR) Program, 24–18 Terminal Doppler Weather Radar (TDWR) System, and 34–13 Terminal Radar Digitizing, Replacement, and Establishment.

Products:

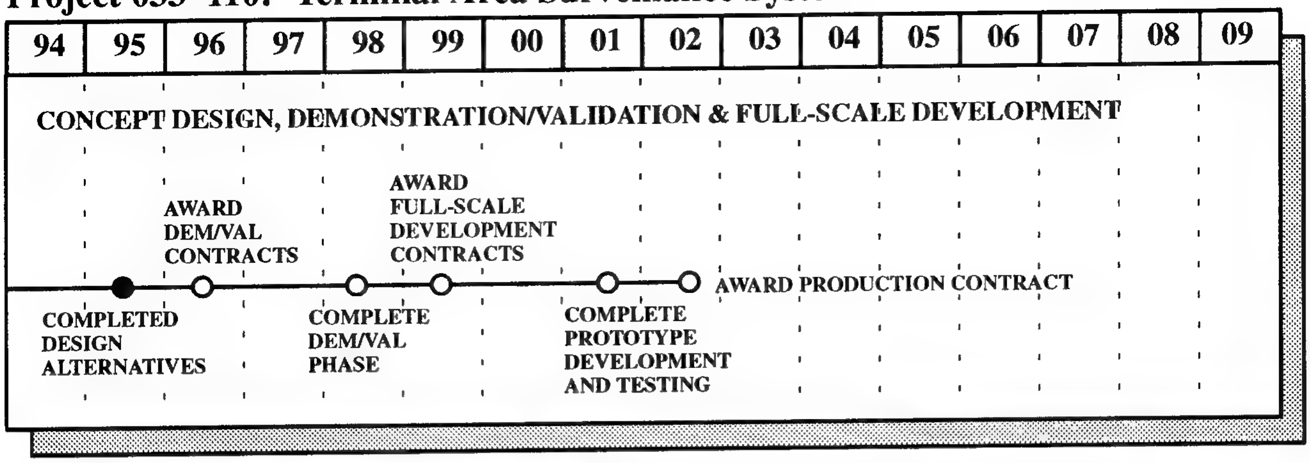
- Operational requirements and design concepts
- Technical requirements feasibility assessments
- Full-scale development prototype
- Production contract

1995 Accomplishments:

- Complete systems alternatives analysis.
- Issue RFP for selected demonstration/validation (DEM/VAL) risk reduction/feasibility activities.
- Complete phased array radar design, initial module fabrication, and demonstration phase planning.

Planned Activities: The DEM/VAL contract for alternative terminal area surveillance system concepts will be awarded in 1996 with the DEM/VAL phase completed in 1998. Following this phase, the best design will be selected for full-scale development from 1999–2001. Upon satisfactory completion of prototype testing in 2001, a production contract award is planned for 2002.

Project 033–110: Terminal Area Surveillance System



4.0 WEATHER

Weather is, and will continue to be, a critical factor in all flight operations. It is the single largest contributor to delays and a major factor in aircraft accidents and incidents. Improved weather forecasts offer the potential for increasing system capacity more cost effectively than most other alternatives, such as new airports and runways. Better short-term forecasts and current information on hazardous weather conditions are critical to ensuring safe flight. Also, timely and accurate weather information is critical to planning fuel- and time-efficient flight plans. Weather service users encompass the entire aviation spectrum, from the student pilot to the operator of the most sophisticated, high-performance commercial aircraft during all flight phases.

The future air traffic management (ATM) system will require highly accurate real-time weather warning products and short- and long-term weather forecasts, covering the time period from a few minutes, up to 3, 6, and even 12 hours into the future. Progress in weather research necessary to develop these products, and to implement a system infrastructure to deliver enhanced weather products to end-users, will be critical to addressing this need.

The aviation weather thrust area includes a combination of Research, Engineering and Development (R,E&D) weather projects and new Capital Investment Plan (CIP) weather initiatives that will build upon ongoing weather system development to realize the full user benefits. Both components are critical to the overall success of the weather system modernization effort.

AVIATION WEATHER MISSION NEEDS

Good flight planning is necessary for all flight operations. A principal need is the capability to provide weather information to support hazardous weather avoidance. In a planning sense, the aviator needs to have good forecast information to avoid hazards in flight.

Efficiency is determined by minimizing time in flight or fuel used. Flight efficiency to a large degree implies the capability for economic or pilot-chosen routing. This capability implies a significant need for timely and accurate strategic weather information during flight planning so that a route can be selected to minimize the need for dynamic rerouting during flight.

In the terminal area, predicting significant wind shifts is needed to optimize runway management. In addition, more accurate wind field analyses will provide terminal air traffic automation systems with optimal descent profiles. Enhanced hazardous weather depiction will mitigate weather impacts on arrival and departure corridors. Improved windshear warnings, microburst detection, thunderstorm predictions, and other products will be particularly important in this regard.

Finally, with the increase in oceanic traffic, and in close connection with oceanic air traffic control, there is a need to establish oceanic weather warning and forecast centers that can provide timely weather information. Improved weather information will provide route flexibility commensurate with systems such as automatic dependent surveillance and will enhance transoceanic flight safety.

WEATHER SYSTEM BENEFITS

Weather detection and forecasts provide a description of the environment surrounding aircraft during all flight phases. Improvements in our ability to understand, forecast, and accommodate changes in the weather, particularly hazardous weather, will yield a wide variety of benefits.

A benefits evaluation of the FAA's new weather initiatives was performed by the System Engineering and Integration Contractor. The contractor estimated that the projects in the CIP and R,E&D Plan will together provide benefits between the years 1991 and 2006 that total $12 billion. These benefits are distributed as follows: safety – $3.61 billion; delay avoidance – $6.13 billion; user preferred route accommodation – $0.40 billion; improved productivity air traffic/ airway facilities – $0.16 billion; and operations and maintenance – $1.78 billion.

4.1 Weather Project Descriptions

041–110 Aviation Weather Analysis and Forecasting

Purpose: This project will enhance the basic understanding of weather as it affects aviation. Since weather impacts on the National Airspace System (NAS) are spatially small (mesoscale), this project will be integrated with other national research program activities that focus on the atmospheric mesoscale analysis and prediction problem. A further purpose is to concentrate research efforts on developing new algorithms, numerical weather analysis and prediction models, and methods to detect/predict the impact from weather hazards. This research will significantly improve weather product and forecast quality, thus enabling aviation weather users to make effective strategic and tactical decisions for aviation operations.

Approach: This project includes three major components: (1) participating in interagency activities to better understand aviation weather phenomena; (2) developing models and algorithms for generating nowcast and short-term aviation-specific products; and (3) developing and testing computer-aided training modules for the users of newly developed forecasting methods and products. These areas include icing forecasts; en route and transition turbulence, ceiling, and visibility; thunderstorm and microburst prediction; wind analysis and forecasting; and oceanic weather observation, analysis, and forecasting.

The objectives in the weather R,E&D program are incorporated in the stated goals of the U.S. Weather Research Program (USWRP), which is a congressionally mandated interagency program under the lead of the National Oceanic and Atmospheric Administration. The FAA will participate in the USWRP to address regional and local scale weather phenomena that are unique to aviation. The USWRP's strategic priorities of most interest to the FAA are to "improve local and regional weather forecasts" and to "achieve efficiencies by coordinating efforts of federal agencies, state institutions, the academic research community, and the private sector." Involvement in the USWRP will benefit a significant portion of the R,E&D program.

The major objective for icing forecasting improvements is to develop an aircraft structural icing forecast capability. This capability will provide accurate delineation of actual and expected icing areas by location, altitude, duration, and potential severity. Another element in the structural icing program is to create a capability to forecast the onset, intensity, and cessation of structural icing on the ground to support deicing activities.

Detecting and avoiding clear air turbulence can improve NAS safety and capacity. This research effort will develop a model for short-term en route and transition turbulence forecasting using wind, temperature, and moisture data. A variety of models will be developed and applied to forecasting wind flow patterns, downbursts, wind direction changes, windshear, and gust fronts for the lower atmosphere.

This research and development project is being coordinated with and accomplished through an interagency agreement with the National Science Foundation and National Center for Atmospheric Research. The Aviation Weather Analysis and Forecasting project will provide current analyses, nowcasts, and short-range predictions of relevant atmospheric fields and hazardous weather phenomena. Products derived from the above information will be tested and evaluated by the Aviation Weather Development Laboratory (AWDL) at Boulder, Colorado, and the Experimental Forecast Facility (EFF) at Kansas City, Missouri, to facilitate transition of appropriate products to operational aviation weather services.

Related Projects: 021–140 Oceanic Air Traffic Automation, 031–110 Aeronautical Data Link Communications and Applications, 033–110 Terminal Area Surveillance System, and 042–110 Aeronautical Hazards Research. Capital Investment Plan projects: 21–12 Advanced Automation System (AAS), 43–02 Meteorologist Weather Processor (MWP) II, 61–22 ATC Applications of Automatic Dependent Surveillance (ADS), 61–23 Oceanic Automation Program (OAP), 63–05 Aeronautical Data Link Communications and Applications, 63–21 Integrated Terminal Weather System (ITWS), and 63–22 Aviation Weather Products Generator (AWPG).

Products:

- Precise and usable algorithms and/or numerical models related to icing, turbulence, convective initiation, visibility, ceiling, and snowstorm forecasting
- New mesoscale numerical data assimilation and prediction models adapted to aviation needs and new methods for nowcasting
- New prototype aviation weather products for AWDL and EFF test and evaluation
- Automated techniques for detecting, quantifying, and forecasting meteorological events
- Computer-aided training modules for using new forecasting techniques and products

1995 Accomplishments:

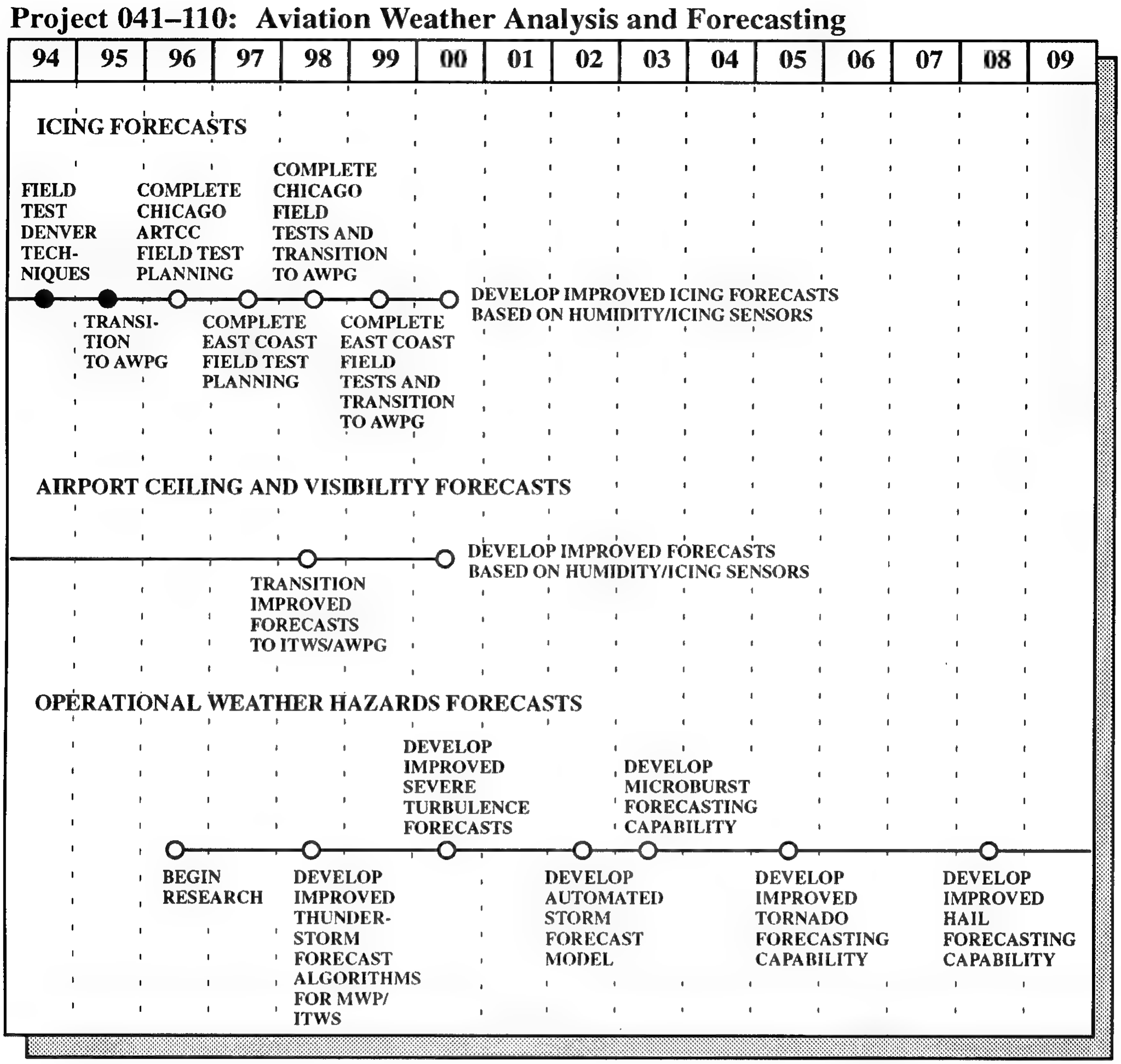
- Transition Denver field test algorithms/information to AWPG.

Planned Activities: In 1996, planning will be completed for Chicago winter icing forecast technique field tests. These tests will take place in 1997–1998, and the results will transition to the AWPG in 1998. In parallel with the Chicago field test, planning for an east coast field test at either Boston or Washington will be completed in 1997. The east coast field test will run from 1998–1999, and the algorithm/information will transition to the AWPG in 1999. Improvements in icing forecasts will continue through 2000 by using the high resolution humidity data available from the airborne humidity sensor developed in the Airborne Meteorological Sensors project.

In 1996, research will continue on automating changes in ceiling and visibility forecasts at airports, with improved forecasts transitioning to ITWS/AWPG in 1998. Further improvements will be developed between 1998 and 2000 using the high resolution humidity data from the airborne humidity sensor.

In 1996, the National Center for Atmospheric Research laboratory will begin an emphasis on weather research activities for the FAA. All research development will transition to the MWP, ITWS, and AWPG programs. In 1996, research will begin on developing new thunderstorm forecasting algorithms with completion expected in 1998. By 2000, an improved severe turbulence forecast algorithm will be completed for transition to operational programs. In parallel with these activities, development will be completed on an automated storm forecast model in 2002. This model will be the basis for an improved predictive microburst, tornado, and hail forecasting capability. A microburst forecasting capability will be developed in 2003, followed by an improved tornado forecasting capability in 2005, and an improved hail forecasting capability in 2008.

This project is coordinated with the Aeronautical Hazards Research project to provide scientific meteorological expertise on clear air turbulence and mountain rotor.



041–120 Airborne Meteorological Sensors

Purpose: This project will develop specialized airborne meteorological sensors to meet unique, critical aviation weather requirements for 3-dimensional basic meteorological data and aviation-related weather characteristics. Ground-based sensors alone cannot provide the 3-dimensional information needed to create accurate icing, turbulence, and visibility forecast products. These airborne sensors will provide early hazardous weather warning in the terminal and en route airspace. The improvements will reduce passenger and crew discomfort, in-flight injuries, and aircraft accidents.

Approach: Meteorological sensors to measure humidity and icing will be developed that can be carried aboard aircraft to provide near-real-time 3-dimensional weather data currently not available from remote sensors. The data obtained from these airborne sensors will automatically be transferred to FAA and National Weather Service weather processing systems by the meteorological data collection and reporting system operated by ARINC.

The technology developed will provide design guidelines and engineering data to support industry production and certification initiatives for airborne meteorological sensors. The FAA will work with manufacturers and operators to accelerate sensor development and deployment. Aviation weather products derived from these sensors will be provided to air carriers in the test and validation phase to validate the user requirements and encourage rapid deployment in the air carrier fleet. Prototype airborne sensors will be developed and evaluated in conjunction with the integrated terminal weather system and aviation weather products generator operational testing. This testing will validate the operational usefulness of adding the airborne data.

An aircraft independent turbulence index can be computed from aircraft dynamic response parameters and pressure field spatial variations. These variations are aircraft frame independent, but have a complicated relationship to the turbulence index. Airframe motion estimates of turbulence must be corrected for airspeed, wing loading, and airframe type to yield a universal turbulence index. Research will be carried out to determine the most cost-effective approach to providing the desired turbulence index. Candidate designs will be tested simultaneously in a test aircraft and the resulting predictions compared with the results of turbulence encounters. Algorithms to estimate significant turbulence areas will be developed and tested operationally at the ITWS/AWPG prototype test sites.

Spaceborne, airborne, and/or ground-based icing sensors may be considered in the future to meet the space and time detection requirements for atmospheric icing. Alternative concepts will be evaluated, prototype sensors will be tested and evaluated, and engineering specifications will be prepared to implement an operational system.

Related Projects: 021–180 Terminal ATC Automation (TATCA) and 031–110 Aeronautical Data Link Communications and Applications. Capital Investment Plan projects: 63–21 Integrated Terminal Weather System (ITWS) and 63–22 Aviation Weather Products Generator (AWPG).

Products:

- Prototype humidity and icing sensors
- Certification of sensors that measure humidity and icing aboard air carrier aircraft
- Design guidelines, engineering data, and functional requirements for the humidity and icing sensors
- Turbulence index algorithms for using sensor data to provide improved turbulence products
- Automated humidity and clear air turbulence reports downlinked from air carrier aircraft

1995 Accomplishments:

- Complete first year of a two-year flight demonstration for humidity sensor and turbulence algorithm.

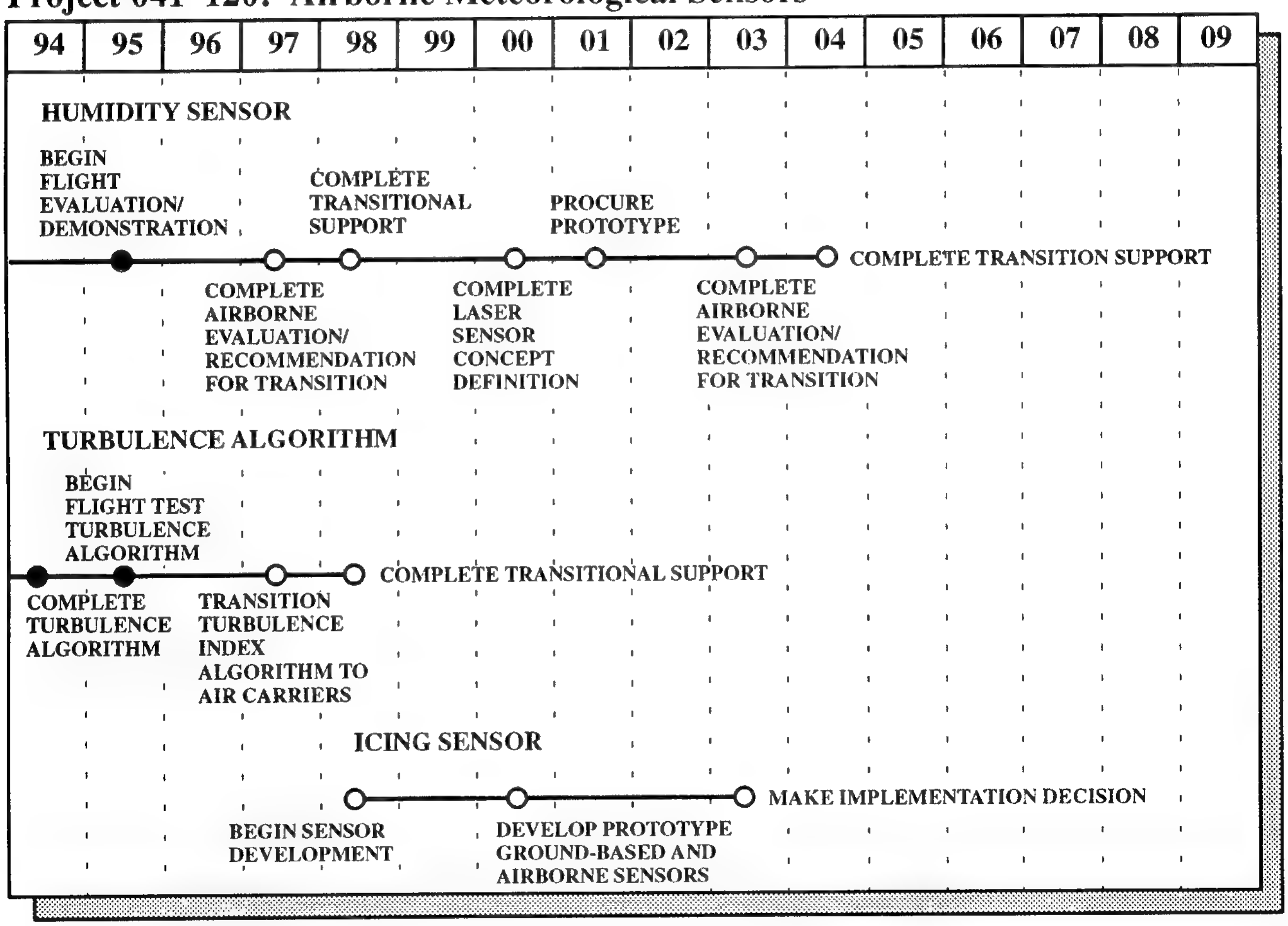
Planned Activities: In 1996, experimental humidity sensors will undergo flight test evaluation/demonstration and operational utility assessments. If these assessments suggest a significant cost/benefit from more rapid humidity profile updates, multiple off-the-shelf sensors will be

recommended for procurement by air carriers in 1997. Transitional support for these procurements will continue through 1998. Future research will concentrate on developing a laser humidity sensor with improved measurement capability. This research will begin in 1998 to develop a completed laser sensor concept definition by 2000. In 2001, a prototype system will be procured for airborne demonstration/evaluation in 2001–2003. In 2003, a decision point will be reached on whether or not to recommend procurement by air carriers. Transitional support will continue through 2004.

In 1996, the turbulence index algorithm will be flight tested to determine the correlation between the index and aircraft performance. In 1997, the turbulence index algorithm will be transitioned to air carriers for implementation. Transitional support will continue through 1998.

In 1998, work will begin on detecting icing aloft using both ground-based and airborne sensors. In 2000, an existing ground-based research radar will be modified to detect icing conditions, and testing will be conducted through 2001. An airborne prototype sensor will be developed in 2000, with testing and evaluation completed by 2002. In 2003, a decision will be made on whether ground-based, airborne, or a combination of sensors is required. Once this decision is made, a transition strategy will be developed.

Project 041–120: Airborne Meteorological Sensors



042–110 Aeronautical Hazards Research

Purpose: Aeronautical hazards such as mountain rotor and clear air turbulence are significant factors in weather related accidents/ incidents. This project will develop, test, and analyze systems to validate airborne technology for detecting these hazards. This research will provide an improved operational capability to detect, monitor, and alert flightcrews to aeronautical hazards.

Approach: This project is divided into two areas: mountain rotor and clear air turbulence.

Mountain Rotor

Following the Colorado Springs air carrier accident in 1991, the National Transportation Safety Board recommended that the FAA study mountain rotor phenomena to develop procedures and technology for detecting and avoiding this hazard. Research will be conducted to define the hazard and collect data on mountain rotor phenomena. A prototype airborne sensor will then be developed with the capability to detect mountain rotors. The prototype sensor will be flight tested and refined, resulting in new technology and requirements for an FAA-certifiable system. In parallel with sensor development, a training program will be developed to enhance aircrew awareness and provide procedures for hazard avoidance.

An important element in this project is leveraging research from the Wake Vortex Separation Standards project in developing a mountain rotor sensor. Certain similarities between the mountain rotor and wake vortex hazards provide an opportunity to integrate research in a collaborative effort. However, sensor technology gained from the wake vortex project will need to undergo development work to make it applicable for detecting mountain rotor hazards.

Clear Air Turbulence

Clear air turbulence is a continuing cause of injuries and aircraft damage in air carrier operations. Therefore, clear air turbulence detection and avoidance research is a high priority for the FAA Flight Standards organization. This project will capitalize on research from the successful Integrated Airborne Windshear Research project by refining/enhancing sensor technology to provide a clear air turbulence detection capability. Research will be conducted to define the hazard and collect data on clear air turbulence. An improved prototype airborne sensor will be developed with the capability to detect clear air turbulence. The sensor will be flight tested and refined resulting in new technology and requirements for an FAA-certifiable system. In parallel with sensor development, a training program will be developed to enhance aircrew awareness and provide procedures for hazard avoidance.

Related Projects: 021–230 Wake Vortex Separation Standards; 031–110 Aeronautical Data Link Communications and Applications; 033–110 Terminal Area Surveillance System; and 041–120 Airborne Meteorological Sensors. Capital Investment Plan projects: 63–05 Aeronautical Data Link Communications and Applications, 63–21 Integrated Terminal Weather System (ITWS), and 63–22 Aviation Weather Products Generator (AWPG).

Products:

- Hazard definitions
- Prototype airborne sensors
- Certification requirements
- Hazard training programs

1995 Accomplishments:

- Complete mountain rotor characterization/ hazard definition.

Planned Activities:

Mountain Rotor

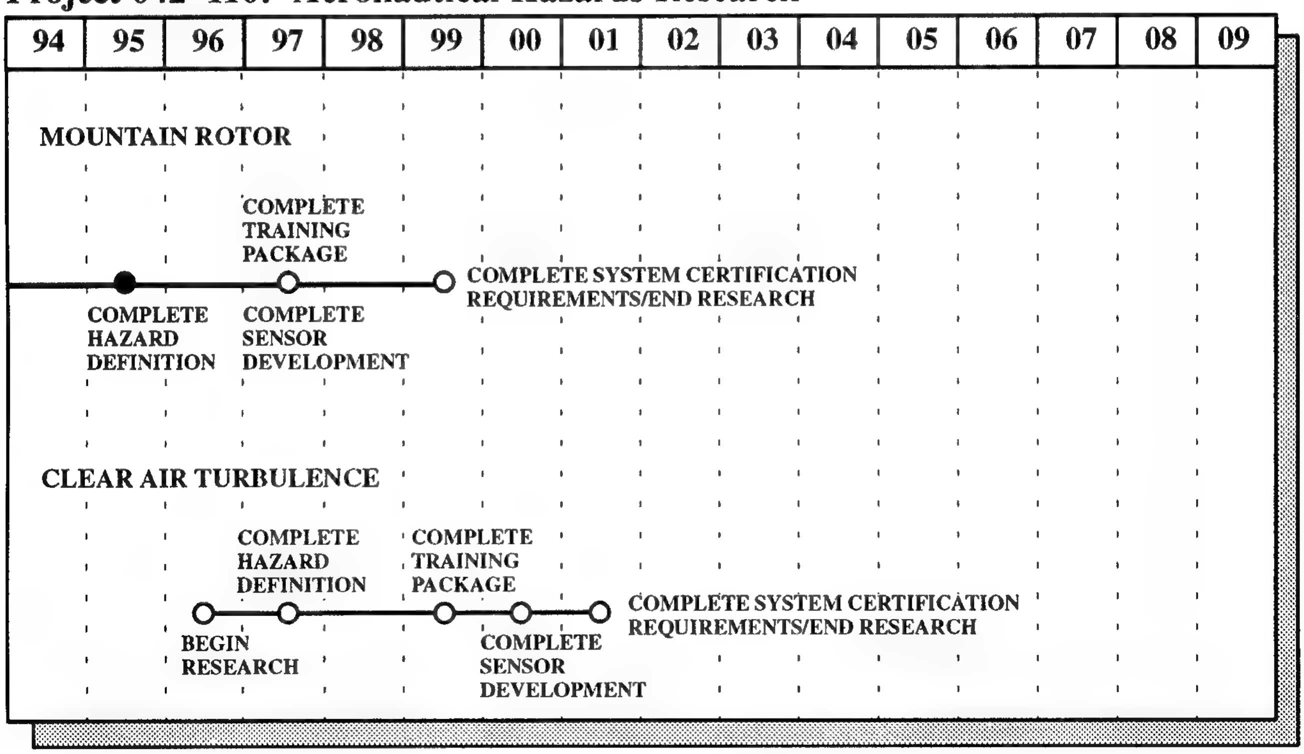
In 1996, mountain rotor research and flight tests will be completed with sensor development expected by 1997. In 1997, development will begin on certification requirements for a mountain rotor sensor, followed by requirements publication in 1999.

In 1996, work will continue on developing a computer-based mountain rotor training package for aircrews that includes new advisory circulars. In 1997, this training package will be completed and available for distribution throughout the aviation community.

Clear Air Turbulence

In 1996, work will begin on clear air turbulence hazard definition. The hazard definition will be completed in 1997, followed by completion of data collection in 1998 for prototype development. Sensor development work will be completed in 2000, with system certification requirements published in 2001. In 1996 work will begin on developing a computer-based clear air turbulence training package for aircrews. This training package will be completed in 1999 and available for distribution throughout the aviation community. The Aeronautical Hazards Research project will end when the clear air turbulence research is completed in 2001.

Project 042–110: Aeronautical Hazards Research



5.0 AIRPORT TECHNOLOGY

The FAA is responsible for encouraging and fostering safe and efficient national airport system development. The Airport Technology Research and Development Program assists in developing new and improved standards, criteria, and guidelines to plan, design, construct, operate, and maintain the Nation's airports, heliports, and vertiports.

There are over 18,000 aircraft landing areas in the United States. Aircraft are increasing not only in number, but more importantly, in weight, landing speed, and overall dimensions. Many airport facilities are reaching design life, and the capital costs of airport improvements over the next 5 years are estimated to exceed $30 billion. Research will be an important factor in the efforts to control costs. Both passenger enplanements and aircraft operations are projected to experience strong growth for the foreseeable future, leading to airport activity levels two or more times greater than today. However, there are limited possibilities for expanding existing airports or building new airports. Consequently, maximum benefits must be derived by maintaining and improving existing facilities and by supporting research that can reduce congestion and delays at airports. Research can also provide innovative means for improving safety, increasing capacity, improving airport access and passenger services, assessing federal investment effectiveness, and supporting U.S.–developed aviation products.

Airport technology research can lead to improved designs, techniques, equipment, and methods to assess system performance that will increase federal investment effectiveness of the $1.9 billion Airport Improvement Program. For example: pavement and other facility lifecycle costs can be reduced; capacity can be improved and delays reduced; and both airports and heliports can be better integrated into the National Transportation System.

Pavement research has the potential for very large benefits. Approximately $2 billion is spent on constructing, rehabilitating, and maintaining airport pavements each year, whereas only $3 million is spent on research. Increasing the average life of pavements by as little as 10 percent through research would result in a cost/benefit ratio of 50 to 1 or more. This objective is not unreasonable or unattainable.

The landside portion of airport design and operation is also addressed in this research area. Projects in this area will help ensure that the systems that bring passengers to the aircraft are also able to handle forecasted traffic levels.

5.1 Airport Technology Project Descriptions

051–110 Airport Planning and Design Technology

Purpose: This project will help improve existing, or develop new, design standards pertaining to runways, taxiways, aprons, and gates. It will also develop standards and advisory information to be used in planning and designing airports, terminals, and ground access systems.

Advances in technology have supported major refinements in the air transportation system and made it possible to transport a large number of people, one-half billion passenger enplanements, each year. But ever–increasing travel demand and projected growth in the next 15 years will influence airport design, layout, and configuration, and require improved landside facilities. A major concern facing the U.S. air transportation industry is how to manage increases in air traffic with improved safety, reduced delays, and minimal operational constraints.

As advances in air traffic control and other airport improvements increase airside efficiency and capacity, passenger facility capacity and access to the airport will become a limiting factor. As passenger facility capacity and airport access become the new limiting factors, these choke points will generate greater community interest and involvement. Optimum airport use will require a smooth and uninterrupted flow of passengers, cargo, and airplanes among the various elements of the airport system.

Approach: The goal of this program is to eliminate runway acceptance rate as a limiting factor in maximizing airport capacity. This goal will be achieved by reducing the runway occupancy time as much as practical. It will also require optimizing the geometry of runway and taxiway exits which will allow aircraft to negotiate turns safely at higher speed. Research will also be needed to support changes in airport ground access plans to respond to concerns about congestion and air quality. In addition, it is necessary to identify the clearance and design requirements of future aircraft and review current airport designs relative to those requirements. Also, simplified methods must be developed for determining terminal, curbside, and airside capacities.

Related Projects: 021–220 Multiple Runway Procedures Development, 024–110 Aviation System Capacity Planning, 051–120 Airport Pavement Technology, 051–130 Airport Safety Technology, and 073–110 NAS Security.

Products:

- Technical data to support advisory material, regulations, and guidance used by the FAA and industry
- Computer programs and user guides for use by the FAA airport community and industry
- Design standards for terminals and parallel runway configurations
- Aircraft/terminal compatibility analyses

1995 Accomplishments:

- Complete analysis on current airport designs for compatibility with new transport aircraft in concept/design stages.
- Develop airport accessibility index tool.
- Complete airport planning standards for Boeing 777.
- Develop ground access planning guidance.

Planned Activities:

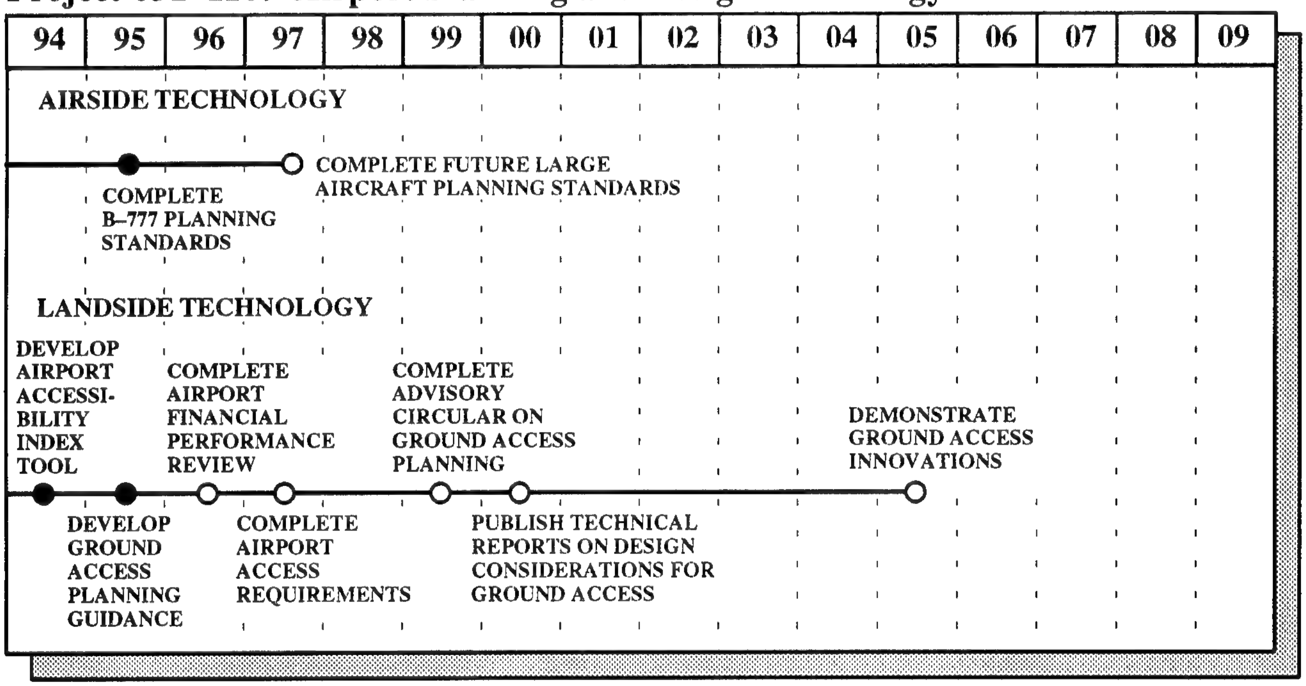
Airside Technology

In 1996, taxiway system design and flow rate evaluation for triple and quadruple parallel runways will continue. Design advisory circulars will be re-examined periodically to determine how airports should be planned and designed to accommodate new, unique aircraft configurations with larger wingspans. Standards will be completed by 1997 for future large aircraft.

Landside Technology

In 1996, an airport financial performance review will be completed. This review, when used with the previously completed ground access guidance, will ensure that Airport Improvement Program funds are efficiently used. In 1997, airport access requirements will be developed, followed by publishing an advisory circular on ground access planning in 1999. Technical reports on design considerations for ground access will be published in 2000, and innovations in airport ground access will be demonstrated from 2003–2005.

Project 051–110: Airport Planning and Design Technology



051–120 Airport Pavement Technology

Purpose: The approximately 650 million square yards of pavement at U.S. airports represent a precious national resource. Replacement value is expected to exceed $100 billion, and there are only limited practical possibilities for adding to or replacing major pavement systems. Consequently, maximum benefits must be obtained from the existing facilities.

The federal Government and the aviation community are spending approximately $2 billion in annual pavement expenditure as well as additional costs of delay resulting from operational interruptions due to construction and maintenance. A significant portion of the $2 billion is spent replacing, repaving, rehabilitating, repairing, and maintaining pavement surfaces. During the next five years, an estimated $30 billion in federal and local funds will be required to provide a more efficient and integrated public–use airport system under the FAA's National Plan of Integrated Airport Systems. Of this total, about half will be spent on constructing, maintaining, and rehabilitating airport pavements. The majority of this money will be spent at the most heavily used airports carrying the largest aircraft.

The goal of this program area is to reduce the large pavement costs by at least 10 percent by 2010. These savings will be achieved through a systematic research program addressing three areas: pavement design and evaluation, pavement materials and construction methods, and pavement maintenance and repairs.

Specific projects will be carried out to develop an integrated method for pavement design that will reduce pavement design and construction costs, reduce pavement failures, lower the costs of maintenance, and reduce pavement downtime and aircraft delay costs. An advanced pavement design based on layered-elastic theory now supports U.S. aircraft manufacturer efforts to introduce new and heavier aircraft. This goal provides an internationally accepted basis for evaluating whether airports can accommodate new aircraft. The new methodology supports U.S. efforts in working with the International Civil Aviation Organization towards adopting a revised, internationally accepted, basis for determining if airport pavements are compatible with new aircraft designs.

Approach:

Pavement Design and Evaluation

Airport pavement design techniques have evolved from the highway design theory developed in the 1920's and extrapolated in the 1940's and 1950's for aviation applications. While this has worked reasonably well in the past, it will not accommodate the dramatic changes associated with new generation aircraft now on the drawing boards. Research in the pavement design and evaluation area will focus on developing an advanced pavement design method that can be applied to the design of both flexible and rigid pavements. Efforts will concentrate first on verifying the layered–elastic design method followed by more rigorous design methods, based on finite element analysis, that can model material properties more accurately. As part of the layered-elastic theory verification, full-scale testing will be required using a test machine that can simulate the multi-wheel configurations of newer aircraft. Evaluation of aircraft response and pavement performance will be initiated at major new airports by installing advanced instrumentation and sensor systems in runways and taxiways. In addition, research will be conducted to develop design criteria and methods for design, evaluation, performance, and serviceability of pavements at airports in cold regions.

Pavement Materials and Construction Methods

Research efforts in this area will include: developing methods to specify and use new or improved materials as substitutes for conventional pavement construction materials; identifying factors affecting airport pavement durability; developing criteria for efficient use of devices, construction materials, and construction techniques; and developing acceptance criteria for coal-tar-based sealants.

A new program, Airport Pavement Performance Monitoring and Analysis, will be initiated for organizing long–term data collection on pavement performance. This program will identify new airport construction projects, determine life cycle costs, and quantify other performance factors for all airports included in the data base.

Pavement Maintenance and Repairs

Research will be conducted to determine probable causes of significant pavement distress and life–cycle costs. Criteria and guidance for using seal coating materials will be developed to effectively enhance pavement longevity.

Special life–cycle cost studies on heavy concrete pavements at Dulles and Dallas–Fort Worth airports will be undertaken because these pavements are at the end of their design lives. Pavement sections that show significantly more or less distress than average will be identified and their condition related to the number of stress repetitions, subsurface conditions, or other factors. The results will then be used to develop guidelines for pavement average life span, life–cycle costs, and to support new design methodologies.

Related Projects: 051–110 Airport Planning and Design Technology and 051–130 Airport Safety Technology.

Products:

- Technical data for pavement design and design life, evaluation, materials, construction, maintenance, and repair
- Software and user guidelines for pavement design and analysis
- National pavement test machine
- Pavement design tools

1995 Accomplishments:

- Issue layered-elastic theory as an interim standard.
- Issue design specifications for national pavement test machine.

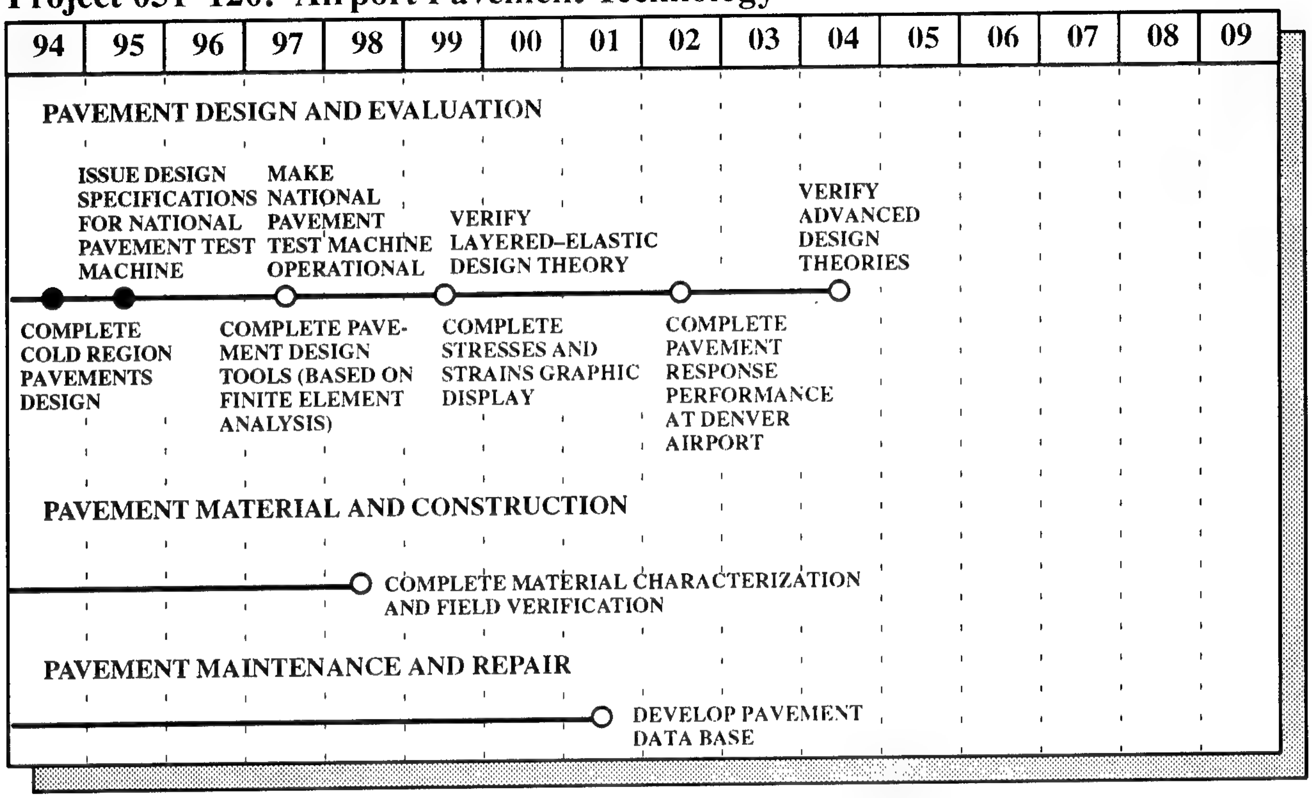
Planned Activities: Extensive research will continue on design and evaluation standards, materials application, construction technology, and pavement maintenance and repair requirements. Major task components include developing: pavement design and analysis methodology based on advanced computational techniques; pavement testing and quality control acceptance criteria; specifications for materials; joint sealant criteria; pavement performance data base; and state-of-the-art pavement evaluation techniques.

From 1996-2002, a multi–year runway data collection effort will continue at Denver International Airport using sensors embedded in the pavement. These sensors will measure the pavement response to repeated heavy aircraft loading. The data collected will be used to validate pavement design theories, and the data collection effort will be completed in 2002. Computer software development using the predictive design and analysis methodology will continue in 1996, resulting in a stress/strain graphic display in 1999. New tests for material characterization will be completed in 1998, and controlled experiments under various applied and environmental loading conditions will be formulated to ensure the methodology's accuracy. In addition, studies will be initiated on durability of asphalt mixes and improved shoulder designs.

In 1996, work will continue on collecting and analyzing data that relate pavement performance to FAA design and construction standards. This effort will result in a comprehensive airport pavement data base in 2001. Criteria and methods for design, evaluation, performance, and serviceability of pavements at airports in cold regions will be developed.

In 1996, national pavement test machine development will be completed, and the machine will become operational in 1997. The pavement test machine will be used to conduct various experiments such as verifying the layered-elastic design theory in 1999 and advanced design theories in 2004. Experiments will be continually run on new materials as they are developed, new construction techniques, and pavement lifecycle determination methods. Pavement design tools based on finite element analysis will be completed in 1997.

Project 051–120: Airport Pavement Technology



051–130 Airport Safety Technology

Purpose: This project will develop new technologies in four research areas: (1) safe and efficient aircraft operations on runway surfaces; (2) new, emerging technologies in lighting, signing, and marking materials for improved visual control systems; (3) new materials, methods, and equipment to improve the capability and cost–effectiveness of airport rescue and firefighting services; and (4) materials, methods, and devices to control birds and wildlife in the airport environment.

Approach:

Runway Surface Technology

A critical safety concern at airports is the runway surface condition. Snow, ice, water, and rubber deposits can result in slipperiness, causing aircraft loss of control during braking as well as making surface movements hazardous. In recent years, grooved runways to control surface water have greatly reduced hydroplaning. However,

aircraft accidents from overshooting or veering off contaminated runways remain a problem.

During the last 11 years, there have been 130 accidents involving aircraft overruns and veeroffs. The accidents involved runway surfaces that were either dry or covered with water, ice, snow, or slush. Major aircraft accidents have focused national attention on the question of runway slipperiness and loss of control during landings and takeoffs. Two recent accidents at La Guardia Airport in 1992 and 1994 identified runway slipperiness and an inadequate safety area beyond the end of the runway as contributing factors.

The goals of this program area are to eliminate by 2000 runway slipperiness as a cause of accidents and develop technologies to safely stop all aircraft within the extent of the runway. To achieve these goals, extensive research, testing, and evaluation will be conducted to develop new techniques, materials, procedures, and equipment to remove ice, snow, and rubber deposits efficiently with minimal adverse environmental impact. Also, research will continue on developing methods to prevent ice and snow accumulation on airport surfaces. In addition, new materials and methods will be investigated to decelerate aircraft safely should there be an overrun.

<u>Visual Guidance</u>

Safe and efficient airport ground operations, especially at night and under low visibility conditions, require that pilots and vehicle operators receive conspicuous and unambiguous information from lights, signs, and markings. Improvements in these visual aids will help to eliminate runway incursions.

During the past 15 years, seven air transport surface collisions in the United States have resulted in 17 fatalities and substantial property damage. In 1990, a collision at Detroit International Airport between two aircraft killed eight people. These accidents have brought into focus the need for providing visual guidance to aircraft in low visibility conditions.

The goal of this program area is to eliminate by 2000 deficiencies in visual guidance systems and procedures that may contribute to surface collision accidents. This goal will require research efforts in two general areas: visual guidance "control" technology to develop an advanced system for aircraft movement on airport surfaces and developing state–of–the–art light sources and applications. These will include fiber optics, laser sources, and holographic techniques. In conjunction with this effort, technology will be developed to evaluate new visual guidance systems and procedures, particularly during low visibility conditions, on a computer–based simulation system.

<u>Rescue and Firefighting</u>

An analysis of aircraft accidents involving external fuel fires has shown that, although external fires can be effectively extinguished, secondary fires within the fuselage are difficult to control with existing equipment and procedures. Large amounts of smoke, toxic gases, and high temperature levels in the passenger cabin can cause delay in evacuation and pose severe safety hazards. The 1991 accident at Los Angeles International Airport involving two aircraft clearly demonstrated this concern. The rescue and firefighting personnel were faced with a post–crash fuel spill fire, a rapidly growing interior fire, and a structural fire. A rapid response to the accident site was accomplished, but evacuation was hampered by the thick black smoke that filled the cabin following the accident.

The goal of this program area is to increase passenger survival rates in post–crash fires by providing a safe evacuation route through the aircraft cabin in a timely manner. This goal will require research and testing to develop firefighting systems that can effectively be used to control both external and internal cabin fires. New methods,

procedures, and firefighting chemicals will be developed for large-capacity aircraft, double-decked aircraft, and/or aircraft made from advanced materials. Research will be carried out to reduce vehicle response during nighttime and low visibility conditions, and to develop new training techniques for rescue and firefighting personnel. Improvements in response times and proper equipment development are needed for operations in poor visibility conditions.

Improvements in soft terrain and off–road firefighting vehicle capabilities will be needed to cope with expanded airport runway configurations into 2000 and beyond. Reductions in off–runway response times will be achieved by developing a new truck suspension system that improves traction in soft sand and wet/uneven ground conditions.

Chemicals used in firefighting training facilities are raising concerns about environmental damage. Research will investigate methods to maintain a high level of performance for firefighting services while minimizing air pollution and ground water contamination.

Wildlife

Wildlife presence at or near airports poses a potential threat to movement of aircraft and other ground vehicles. In spite of various control devices in use to keep birds away, over a thousand bird strike incidents are reported every year. Many more incidents are known to occur, but are not reported.

Since 1912, when the first fatal accident of a Wright Flyer was recorded, 104 civil aviation fatalities from bird strikes have been reported in the United States. Worldwide civil aircraft fatalities total approximately 126, and the potential for a serious accident continues. Bird strike damage cost has been estimated at $1 billion annually by the Europe Bird Strike Committee.

The goals of this program are to increase airport safety and decrease damage to aircraft by reducing bird strikes. These goals require research efforts in developing effective regional wildlife habitat management to minimize or eliminate sources of bird attraction at airports. Research will also be conducted to identify active and passive harassment techniques that can effectively control the presence of birds and other wildlife at airports. These techniques and methods will assist airport owners and operators in complying with FAA airport certification regulations. Land use siting compatibility guidance will be provided by researching relationships among birds, airports, and landfills.

Related Projects: 021–190 Airport Surface Traffic Automation (ASTA), 051–110 Airport Planning and Design Technology, 051–120 Airport Pavement Technology, and 061–110 Aircraft Systems Fire Safety. Capital Investment Plan projects: 62–21 Airport Surface Traffic Automation (ASTA).

Products:

- Technical data supporting rules, regulations, and advisory circulars on runway surface maintenance
- Technical data and design criteria for lighting and marking systems for airports, heliports, and vertiports
- Technical data on tests and evaluation of firefighting agents, full-scale systems, and rapid response, all-terrain firefighting vehicle
- Technical data and advisory circulars on wildlife habitat management, bird harassment techniques, and landfill studies

1995 Accomplishments:

- Publish fourth report on wildlife harassment/ deterrent techniques for airports and second report on landfill studies.
- Issue standards on runway sand application rates.
- Complete prototype soft ground arresting system installation at John F. Kennedy International Airport (JFK).
- Complete technical report on electrically conductive asphalt pavements.
- Publish specification for improved airport pavement marking.
- Provide technical data for developing U.S. standards for holding position lights.
- Develop specifications for equipment to aid firefighting response in Category IIIC poor visibility weather conditions.
- Develop airport firefighting attack strategies using an elevated waterway device and a boom-mounted interior firefighting penetration appliance. Approved an alternative 3-dimensional running fuel fire extinguishing agent to ozone-damaging Halon 1211.

Planned Activities:

Runway Surface Technology

In 1996, testing will continue on innovative ice prevention/removal techniques. A final report will be completed in 1997, leading to an advisory circular in 1998.

In 1997, standards will be issued for airport soft ground arresting system design and installation. In 1998, development work will begin on updating these standards for new transport aircraft and arresting materials. These standards will be updated by 2005 to accommodate the new, large, wide–body aircraft.

In 1996, research will investigate methods for removing rubber deposits from runways while maintaining pavement integrity. By 1998, guidance will be issued on ways to optimize rubber removal without reducing pavement life.

Visual Guidance

In 1996, work will continue on developing an advanced visual guidance system that controls and guides aircraft taxiing to and from the runway in low visibility conditions. In 1997, a prototype system will be evaluated, leading to standards in 1998.

In 1996 through 2000, advanced technology lighting sources such as fiber optics, laser light, and holograms will be evaluated for potential inclusion in more efficient airport visual guidance systems. Fiber optic and laser technology will be evaluated at the FAA Technical Center in 1997, followed by field prototype and evaluation in 1998, with standards issued in 1999. Hologram technology will be evaluated in 1998, followed by field prototype and evaluation in 1999, with standards issued in 2000.

Rescue and Firefighting

In 1996, work will continue on evaluating strategies for attacking post-crash fuel fires on new, multi-level, high density seating, passenger aircraft. Elevated waterways and boom penetration devices will be used to provide increased passenger evacuation protection for aircraft having five hundred or more passengers. Also in 1996, work will continue on developing training requirements as well as operational strategies for firefighting response at airports conducting operations to zero zero weather conditions. Also in 1996, work will continue on providing fire truck crews with information for efficient rescue operations following a crash. Efforts will continue on evaluating the rescue firefighting standards

against requirements to control and extinguish fires in aircraft containing composite material.

In 1996, an evaluation will be initiated for aircraft rescue and firefighting training simulators. A study will begin on a model, full–scale firefighting training facility that meets both environmental concerns and operational requirements. Based on this research, the current training advisory circular will be updated in 1998 for a standardized, model firefighting training simulator.

In 1997, the current fire protection advisory circular will be updated to include new–generation transport aircraft, such as the Boeing 777. It is expected that the advisory circular will be updated in 2000 to include fire protection for aircraft in the 600–800 passenger capacity and in 2006 to include aircraft up to 1,000 passengers. In the 2005–2010 timeframe, research will be conducted on fire protection requirements for future high-speed civil transports.

In 1996, an advisory circular will be published to address technologies that deal with firefighting procedures for advanced composite aircraft and structures. In 1996, an advisory circular will be published to cover technologies that improve response during poor visibility conditions for firefighting vehicles.

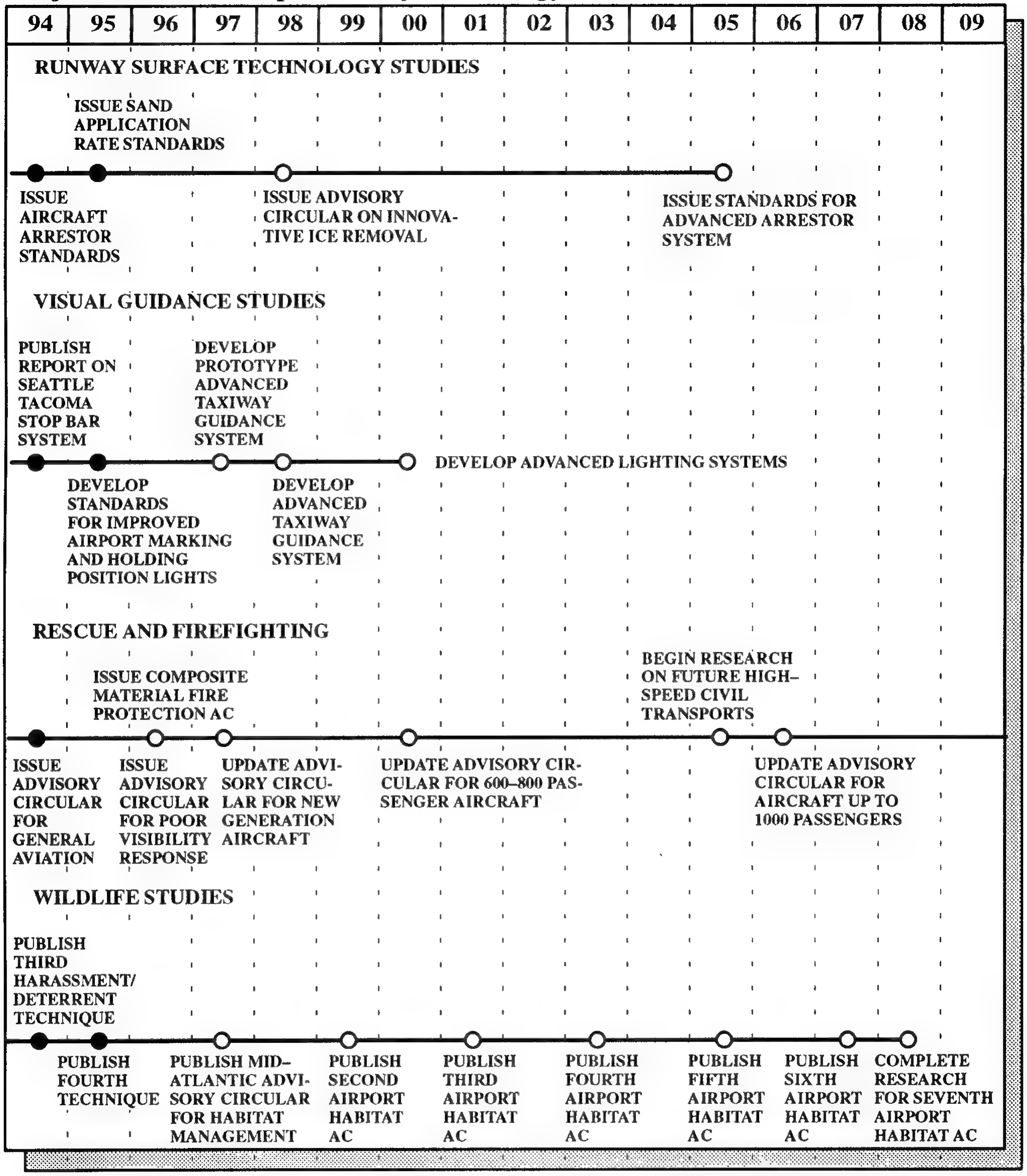
Wildlife

In 1996, the second regional airport habitat management study at O'Hare International Airport will continue. Research on a fourth wildlife harassment/deterrent technique and landfill studies will also continue.

In 1996, a final report will be issued on the Atlantic City habitat study, and a Mid–Atlantic U.S. advisory circular will be completed in 1997. The third regional habitat study will begin in 1997 and conclude in 2001. A final report on the fifth wildlife harassment/deterrent technique will be finished in 1996. Regional habitat management studies will be initiated and completed every 2 years until the 10 regional studies are finished. These regional airport studies will continue through 2008, with advisory circulars published 1 year after final reports. In 1996, landfill studies will continue as scientific evidence describes the link between gull populations and solid waste facilities as well as their effects on airports and aircraft traffic.

The primary thrust of the wildlife research efforts is to identify and document the effectiveness and applicability of new wildlife habitat management and harassment/deterrent techniques for use on or near airports to mitigate bird and wildlife hazards. Knowledge of bird relationships to existing and new solid waste facilities will establish a sound scientific basis to evaluate potential bird attraction effects on or near airports.

Project 051–130: Airport Safety Technology



6.0 AIRCRAFT SAFETY TECHNOLOGY

Today's passenger safety depends on fault–free maintenance and operation of the Nation's civil aircraft. Tomorrow's passenger safety depends on steps taken now to ensure future aircraft reliability and their operator's competency. The steps taken today by the FAA for future safety are embodied in the Aircraft Safety Technology Program. This program addresses the many hazards that face all aircraft in flight, as well as special hazards endemic to select portions of the civil aircraft fleet. Older aircraft are more susceptible to structural problems associated with fatigue and corrosion. New aircraft, with their digital flight control and avionics systems and associated imbedded software, are more susceptible to upset from external electromagnetic interference. The main hazards the FAA Aircraft Safety Research Program addresses are represented in Figure 6.1.

Aircraft safety improvements will reduce fatalities and injuries, reduce hull losses, improve aircraft designs, and impact maintenance and inspection procedures. Each project in this thrust area has the potential to provide significant benefits. For example, more efficient nondestructive airframe testing could produce $40 million per year in benefits. A similar improvement in engine maintenance efficiency could achieve $20 million per year in benefits. An additional $30 million per year could accrue from these two projects due to using more effective inspection techniques and avoiding major engine failure incidences.

Research in aircraft fire safety has the potential for accruing large benefits. Statistics show the United States has about 30 to 35 fire fatalities per year in otherwise survivable accidents, and about 135 fatalities worldwide. At an estimated cost of $1.5 million per life, saving 3 people per year would pay for the entire fire safety research, engineering, and development effort.

Over the past 20 years, the aircraft accident fatality rate has been nearly level at just under two deaths per 10 million passengers carried. This statistic is a tribute to aircraft safety provided by the designers, operators, and regulators. Because the civil fleet's size increased over this period, the leveling fatality rate translates into an increase in total fatalities. These statistics indicate that new safety problems have been arising as old ones have been eliminated. Further, some safety problems such as fire and crashworthiness have continued to persist. Other potential problems, such as flight critical software–based digital fly-by-wire flight control systems, have not had sufficient operational exposure.

Maintaining the good safety record over the past two decades has required introducing new safety technologies, such as cabin floor emergency escape lighting and seat fire blocking layers. Such enhancements are in addition to scores of pre–existing safety requirements for aircraft. Examples include design requirements for the aircraft structure so occupants can survive rapid decompression at cruise altitudes and demonstrations proving that all cabin passengers can evacuate within 90 seconds for each newly certificated transport category model. The most important purpose of FAA aircraft safety research is to develop technical requirements for safety improvements needed to maintain or improve the safety level in an evolving aviation environment.

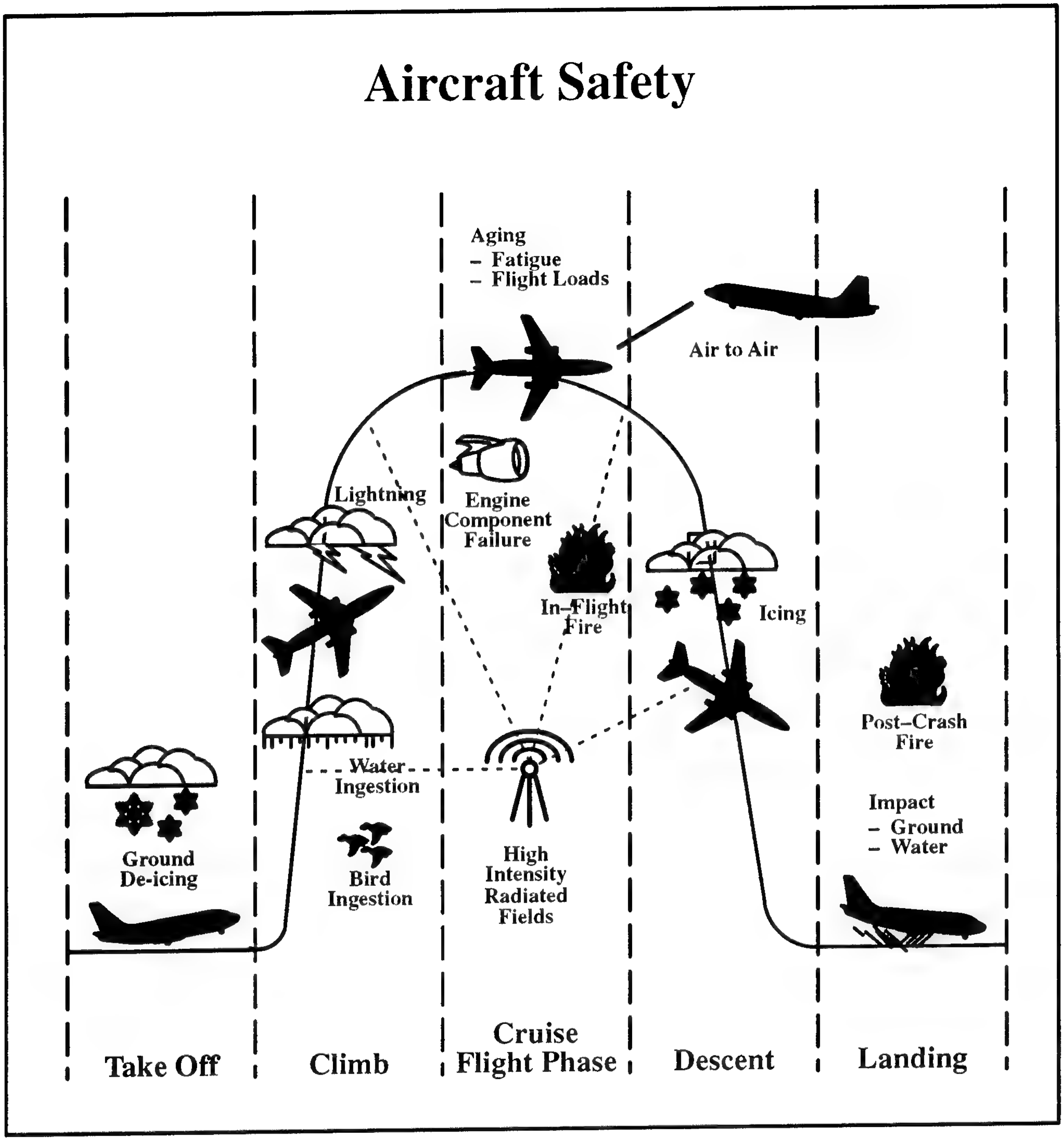


Figure 6.1 Typical Flight Hazards

6.1 Aircraft Safety Technology Project Descriptions

061–110 Aircraft Systems Fire Safety

Purpose: This project will minimize fire–related injuries and increase survival rates for aircraft occupants during in–flight and post–crash fires. It will also improve aircraft fire detection and suppression capability, thereby decreasing the potential for igniting aircraft materials and reducing hull losses in the civil aircraft fleet. The fire safety performance requirements involve fire hardening the fuselage structure and interior cabin materials to increase available evacuation time and reduce fire hazards. Research will lead to new systems and procedures to increase fire safety.

Approach: Aircraft fire issues are unique when compared to fire safety issues in buildings, residences, and ground transportation. In–flight fires must be reliably detected, suppressed, and contained to allow adequate time for descents, landing, and passenger evacuation. With the worldwide ban on Halon extinguishing agent production, it is imperative to test new agents/systems and develop their means of approval for maintaining the current level of in-flight fire safety. During an aircraft crash, impact energies, coupled with the aircraft fuel load, result in a high potential for exterior fuel fires and injuries or fatalities. Studies will be conducted to determine airplane design characteristics that have the potential to increase fire safety. Promising improvements include an onboard cabin water spray system, fuselage hardening against burnthrough, structural composite flammability testing, and protecting oxygen systems. The majority of the work will be conducted by inhouse fire safety specialists at the FAA Technical Center's unique aircraft fire test facilities. The Aircraft Systems Fire Safety project will coordinate closely with the new Fire Research project.

Related Projects: 062–110 Advanced Materials/Structural Safety, 063–110 Propulsion and Fuel Systems, and 067–110 Fire Research.

Products:

- Upgraded aircraft material fire test handbook
- Guidelines for cargo compartment fire protection
- Upgraded fire performance criteria for aircraft cabin materials
- Requirements for approving halon alternate extinguishing agents
- Design for an optimized onboard cabin water spray system
- Improved fire hardening for fuselage structure
- Enhanced fire detection, fire management, and decisionmaking for in–flight fires

1995 Accomplishments:

- Complete tests on fire hardening materials and concepts to protect against fuselage fuel fire penetration.
- Evaluate Halon 1301 cargo compartment fire suppression alternatives, including water sprays, water fogs, and pyrotechnically generated dry powders.
- Develop a standard Halon equivalency performance test for new portable extinguisher agents used against hidden in-flight fires.

- Validate the relationship between in-service fire-blocking layer material degradation and laboratory wear.

Planned Activities: This project will be divided into three major areas: materials fire safety, fire management, and systems.

Materials Fire Safety

In 1996, design guidelines will be developed for hardening aircraft fuselages against penetration by an external postcrash fuel fire. Examples of material designs likely to be affected include thermal acoustical fiberglass insulation, honeycomb sidewall panels, and air return grills. From 1996–1999, research will be conducted to examine the need for fire test procedures for structural components such as control surfaces and floor beams made from composite materials. If research determines that test procedures are warranted, these procedures will be developed by 1999.

A continuing concern is how long fire resistant materials/treatments last during a component's service. In 1996, test procedures will be developed that measure fireworthiness retention properties of seat fire-blocking layers. These testing procedures will be used to develop guidelines, as needed, on aircraft seat material fireworthiness safety.

In 2000–2005, research will be conducted to develop improved fire test requirements for cabin and structural materials in future aircraft designs such as the high–speed civil transport and the 800-plus passenger transport. In 2000–2002, full–scale tests will be conducted to collect data on the material behavior in future aircraft designs. These data will be used to develop laboratory testing procedures by 2003 for establishing a correlation between laboratory and full–scale test results by 2004. In 2005, final fire test design criteria will be developed.

Efforts to resolve agency certification issues related to material fire test requirements will be supported by continuing to sponsor and conduct the International Working Group on Aircraft Material Fire Tests.

Fire Management

From 1996–1997, alternate agents developed by industry to replace Halon 1301 will be tested under full–scale conditions in cargo compartment and engine nacelle applications. In 1996, the focus will be on gaseous agents with zero or near–zero ozone depletion potential such as iodine–containing fluorocarbons, hydrofluorocarbons, and hydrochlorofluorocarbons approved by the Environmental Protection Agency. Full–scale tests will be used to re-create realistic fire scenarios and environmental/operational conditions. In 1997, the test results will be used to develop certification criteria for approving alternative agents with equivalent effectiveness to Halon 1301.

In 1996, onboard cabin water spray research will continue to improve the system's cost effectiveness. A risk analysis model will be developed in 1997 to determine the reduced probability of fire fatalities on future aircraft that have cabin water spray systems. In particular, large transports with 800-plus passengers and the high-speed civil transport will be evaluated.

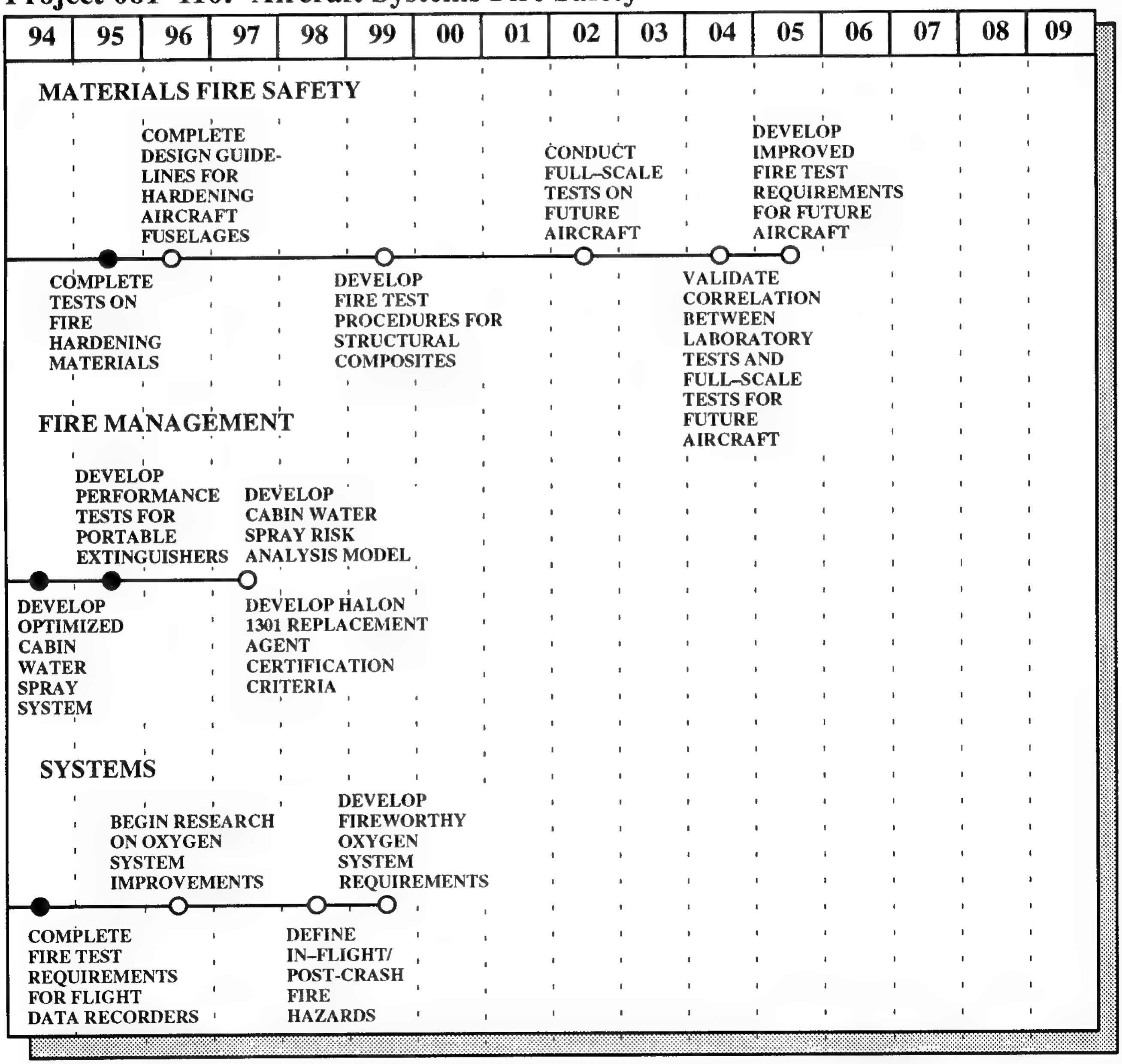
In 1996, tests will be conducted on representative FAA–approved cargo compartment smoke detectors under both flaming and smouldering fire conditions. These tests will evaluate detector response time and sensitivity. Based on this analysis and other relevant compartment parameters, a standardized certification test procedure will be developed in 1997 that measures detector response rates for compliance with existing regulations.

Systems

In 1996, work will begin on evaluating the hazards associated with fires initiated or intensified by emergency oxygen system malfunctions/failures. Actual oxygen systems, including both compressed oxygen and oxygen-generating canisters, will be tested in 1997–1998 to define in-flight fire and post-crash fire hazards. Improved installations, protective measures, and possible system redesigns will be tested and evaluated in 1998–1999. The goal is to develop requirements for fireworthy oxygen system improvements by 1999.

In 1996, support for National Transportation Safety Board aircraft fire investigations will continue, including participation on accident investigation teams, accident material and fluid chemical analysis, and full-scale fire tests to recreate/analyze accident scenarios.

Project 061–110: Aircraft Systems Fire Safety



062–110 Advanced Materials/Structural Safety

Purpose: This project addresses concerns in two major areas. The first area is a lack of information and standards for certifying aircraft made from composite and advanced materials. Advanced composite material structural safety research will focus on acquiring the necessary knowledge to support certification and airworthiness regulations. The second area addresses crashworthiness structural safety and ways to increase protection for both occupants and crew during an accident. Research will be conducted to develop and validate test procedures necessary for generating required data. These data are needed to support certification standards, performance specifications, advisory circulars, and other regulatory materials necessary to enhance aircraft crashworthiness and occupant safety.

Approach:

Advanced Materials

Research will focus on technology issues identified in the Aircraft Advanced Materials Research and Development Plan which has been coordinated with the National Research Council of the National Academy of Sciences' findings. Management of this technical effort is accomplished by focusing on three technology task areas: materials, structures, and manufacturing/supportability. The materials area will investigate the mechanical properties of composite and other advanced materials. The structures area will investigate damage tolerance, environment, joints, and other structural or fatigue concerns. The manufacturing/supportability area will analyze and develop standard process characterization procedures, control criteria, and production readiness. The data generated will be used by FAA personnel and will form the basis for rulemaking, advisory circulars, and training.

These research efforts will be accomplished in part via the University Grant Program, interagency agreements, memorandums of understanding, Centers of Excellence, and the Small Business Innovation Research Program.

Structural Safety

This project establishes a technical data base to generate structural airworthiness and aircraft crashworthiness criteria for both fixed–wing and rotary–wing aircraft. Experimental and analytical research efforts will be developed to create guidelines and performance criteria that ensure continued aircraft structural airworthiness. These efforts will help reduce occupant injuries and fatalities during a crash.

Aircraft crashworthiness includes three areas: airframe structures, aircraft interior, and analytical modeling/computational methods. The airframe structures area will analyze the crash environment, aircraft fuel systems, and structural components to identify and address structural failures. The aircraft interior area will analyze seat/restraint systems and interior furnishings. Analytical modeling/computational methods will be used in developing improved structural, occupant, and seat/restraint systems.

Related Projects: 061–110 Aircraft Systems Fire Safety, 063–110 Propulsion and Fuel Systems, 065–110 Aging Aircraft, and 066–110 Aircraft Catastrophic Failure Prevention Research.

Products:

- Data package addressing certification criteria for seat/restraint systems
- Technical data packages on crash–resistant fuel system designs
- Data package and analysis of rotorcraft exposed to a water impact environment

- Data package characterizing aircraft structural responses when exposed to various terrain impact environments

- A software package for airframe structural analysis (KRASH) computer code upgraded for water and soft soil impact environments

- Integrated crashworthiness analytical modeling program between the FAA and the United Kingdom

- Handbook for FAA personnel on new composite technologies and manufacturing/inspection/analysis techniques

- Composite component probabilistic design feasibility assessment

- Data package on damage tolerance for structures constructed using advanced materials

1995 Accomplishments:

- Complete longitudinal crash testing on a fuselage section with conformable auxiliary fuel tank and overhead bins.

- Develop KRASH code enhancement for water impact environment.

- Develop prototype commuter aircraft energy–absorbing seat design.

- Establish coordinated crashworthiness analytical modeling program between the FAA and the United Kingdom.

- Complete composite material aircraft vertical drop test at the National Aeronautics and Space Administration (NASA).

- Complete transport category water impact analysis.

- Complete composite structure design criteria for resistance to low velocity impact damage.

- Develop composite structure repair material standards.

- Complete data base for damage tolerance of flat and curved panels.

Planned Activities:

<u>Advanced Materials</u>

In 1996, investigations will continue on damage resistance and tolerance studies for aircraft fuselage applications. Further assessments of probabilistic design methods will continue with a goal to publish guidelines in 1999. Work will also continue on the following: investigating composite material test methods; studying damage accumulation in composites from repeated loads to establish test protocols for aircraft certification; and developing analytical modeling for composite structure delamination. This research will result in developing new test methods in 1997 for conducting mechanical property tests.

In 1996, new initiatives will include: evaluating developments/applicability for advanced high speed aircraft design and fabrication technology; updating the FAA's handbook on fiber–reinforced composite manufacturing/repair; developing a refined analytical model that predicts the response and failure of bolted composite joints.

The investigations for advanced composite/metal aircraft structures and the high-speed civil aircraft research will continue into 1997 and 2005 respectively. An intermediate milestone in 2001 will be to establish certification guidelines for aircraft parts constructed from new material forms using automated equipment. The fabrication processes include textiles such as 3–dimensional braiding, resin transfer molding, and stitching.

Structural Safety

Testing and analysis related to aircraft structures will be completed in 1996 and 1997, respectively. Also in 1996, a vertical drop test will be conducted on a Shorts 330 which represents a typical metal 30-passenger commuter aircraft. Testing will be completed in 1997 on a commuter aircraft that utilizes composite materials. This testing will be accomplished through an interagency agreement with NASA.

In 1996, a vertical drop test will be completed on a conformable auxiliary fuel tank. In 1997, an auxiliary fuselage fuel tank system analysis will be completed to develop recommendations for guidelines. The analyses will be completed for crash resistance of fuel lines, fittings, and auxiliary tanks in 1997. Empennage and fuel tank analyses will be completed in 1998, and wing tanks in 2002.

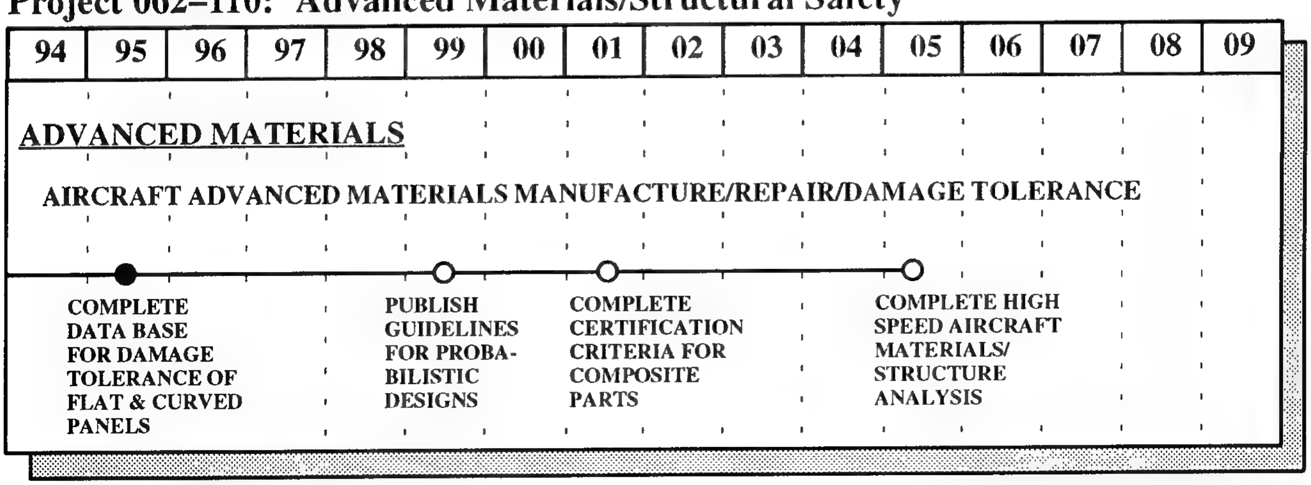
Overhead bin testing for various transport category aircraft configuations will continue through 1996.

In 1996, testing associated with various commuter cabin safety issues will continue. Also in 1996, advanced aircraft energy-absorbing seats will be fabricated and tested at NASA, and two airframe side-mounted seats will be tested in a Beech 1900 drop test. Data collected from these drop tests will be used to improve seat designs and models. Energy-absorbing seat criteria will be developed in 1999.

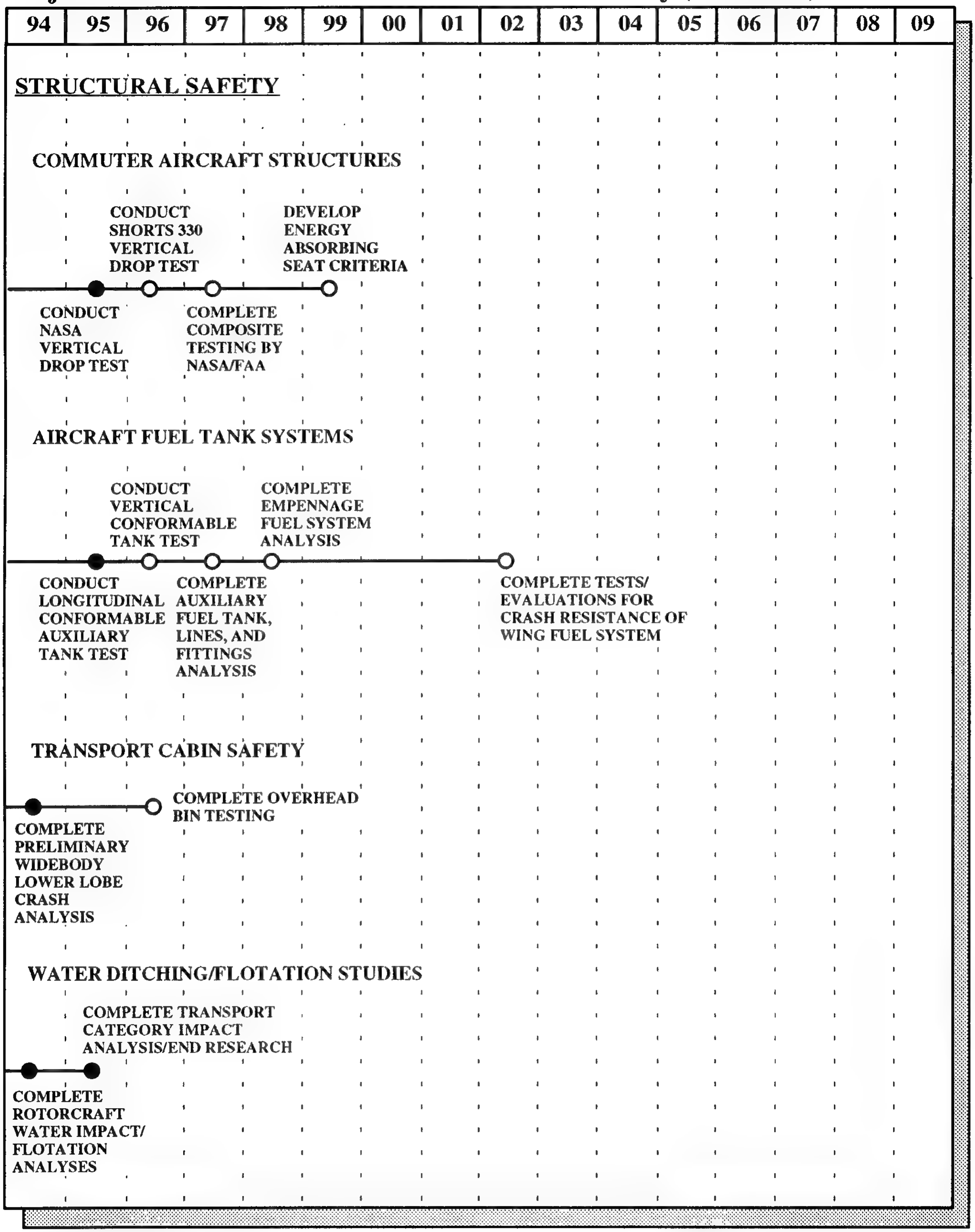
In 1996, work will continue on an integrated crashworthiness analysis program (ICAP). A prototype version ICAP will be developed in 1997 with a completed system in operation by 2002. This effort will complete the joint FAA/United Kingdom research program. In 1997, the KRASH code will be upgraded with a soft soil impact algorithm that will be validated against impact test data collected at NASA. KRASH analytical model development will continue through 2000 to add features to the program. Upgraded versions of KRASH and seat occupant modeling will include all seat/restraint/occupant and airframe research and development. By 2001, a generic KRASH aircraft computer model library will be developed that represents the in-service aircraft fleet.

In the 2000–2004 timeframe, concept development and analyses will be conducted to develop an advanced replacement for the KRASH computer model. By 2004, an advanced computational structural methodology prototype will be developed to undergo evaluations through 2007. Data gained from these evaluations will be used to refine the methodology and make it available for implementation by 2009.

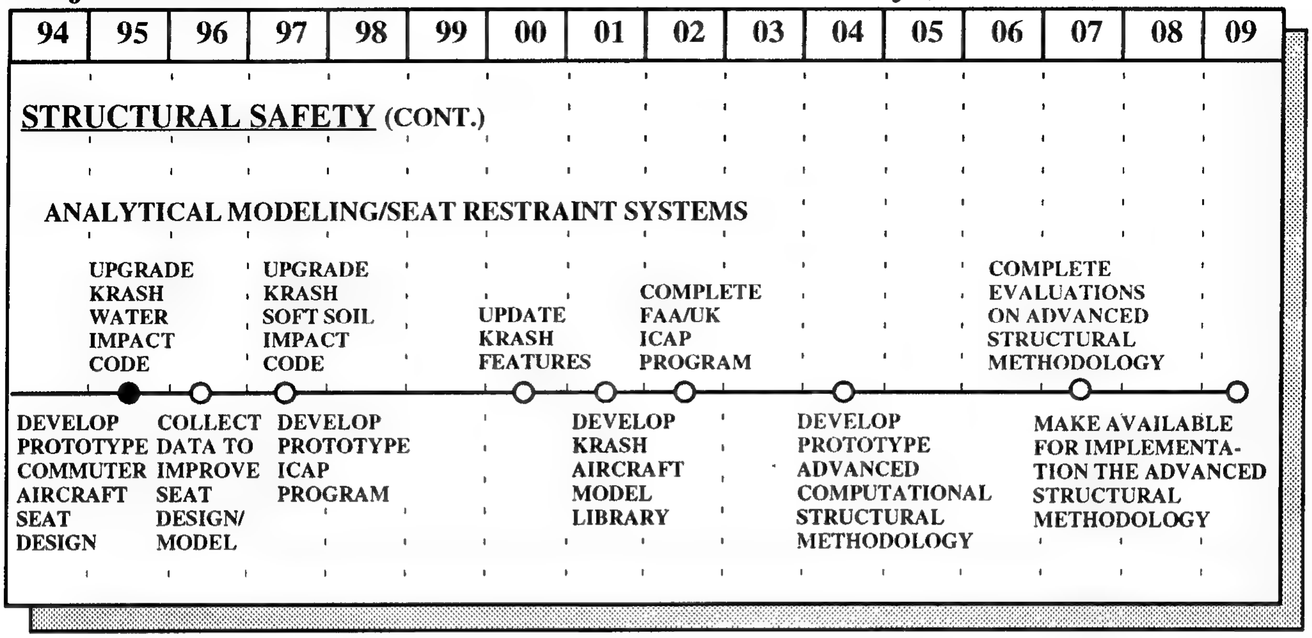
Project 062–110: Advanced Materials/Structural Safety



Project 062–110: Advanced Materials/Structural Safety (continued)



Project 062–110: Advanced Materials/Structural Safety (continued)



063–110 Propulsion and Fuel Systems

Purpose: This project will address safety issues as new fuels and materials are employed in the next generation aircraft. Superalloys, ceramics, and coatings will permit the engines of the 1990's and beyond to operate at higher temperatures and pressures. However, future engine durability is a concern as thermal and mechanical fatigue/fracture problems are likely to become more serious. Additionally, environmental and economic issues will force a change in fuels used to power civil aircraft. Performance, safety, and durability issues will be affected by the transition to these new fuels. This project will provide FAA certification offices with the data needed to generate new standards, and will develop a data base for industry use to aid in transitioning to the future technologies.

Approach: This project develops criteria, guidelines, and data to support improvements in turbine and piston engine certification requirements. The primary research and development areas are engine reliability, engine structural safety, and future fuels/safety.

<u>Engine Reliability</u>

Analyses in progress will determine if current standards adequately address engine durability problems under extreme operating temperatures and pressures. Advanced engine safety and reliability will be continuously assessed as these engines are developed for future commercial and general aviation (GA) aircraft.

An analytical study on the water ingestion process in the jet engine combustion section will be initiated. This study will complement a previous study conducted on the compressor section. In-service operation data will be analyzed to identify potential problems from hail or other foreign object ingestion.

Another study will be undertaken to determine if sensing flammable mixtures in powerplant installations is feasible and to develop engine case burnthrough test standards.

Research will be conducted to develop technology and establish a technical data base for engine component production, in–service inspection methods, and material manufacturing processes.

Engine Structural Safety

Work will continue on developing lightweight containment materials and analyzing turbine engine rotor failures. The materials under consideration include composite weaves, ceramics, and advanced metallics. Technology will be developed to predict or diagnose a turbine engine rotor structural failure.

Future Fuels/Safety

Data will be generated on using unleaded gasolines in aircraft piston engines through ground–based testing, flight tests, and laboratory studies. Specific concerns include: engine performance, fuel consumption, engine knock, hot fuel certification, material compatibility, engine durability, and exhaust emissions. Factors that affect aviation fuel availability will be monitored and research initiated as needed to address both safety and reliability concerns. The results from a previously completed fuel risk assessment will be used to evaluate promising approaches for improving post-crash fuel containment on transport category aircraft. A future study will investigate the effects of elevated fuel temperatures expected on high-speed civil transports.

Related Projects: 062–110 Advanced Materials/Structural Safety, 065–110 Aging Aircraft, and 066–110 Aircraft Catastrophic Failure Prevention Research.

Products:

- Analytical design tools to define engine performance during excessive hail/water ingestion
- Design criteria and material specifications for containing turbine engine rotor failures
- Advanced engine rotor design material criteria
- Advanced fire protection criteria and prototype hardware for turbine engine powerplant installations
- Risk assessment and techniques to mitigate post–crash fuel fire hazards
- Improved turbine rotor nondestructive inspection standards
- Recommendations for certification standards on general aviation fuels
- Procedures and software for industry use on octane requirements and engine knock characteristics

1995 Accomplishments:

- Develop performance criteria for turbine engine rotor and onboard failure diagnostic techniques.
- Develop generic analytical model to evaluate turbine engine performance during hail/water ingestion.
- Complete general aviation engine performance ground testing using unleaded fuels with additives and issued report.

- Conduct flight tests to correlate ground-based data with actual flight conditions for new aviation fuels.

- Recommend unleaded aviation gasoline specification.

Planned Activities:

Engine Reliability

In 1996, fire burnthrough test standards and equipment will be evaluated for power plant installations. Detecting hazardous conditions in engine nacelles has been unreliable, resulting in false alarms, aborted takeoffs, and forced landings. More reliable methods to detect combustible mixtures in the nacelle area will be evaluated in 1996. Data collected from these analyses will be used to develop a prototype nacelle fire detection system in 1998 that will be used for field testing through 2000. Data from field testing will be used to develop recommendations on nacelle fire detection systems for handoff to certification agencies by 2002.

In 1996, work will begin on developing an analytical model that includes water and hail ingestion with completion expected in 2001. Current efforts to develop performance data on engine inspection techniques will be completed in 1998. Advanced turbine engine maintenance and repair criteria will be developed by 1998.

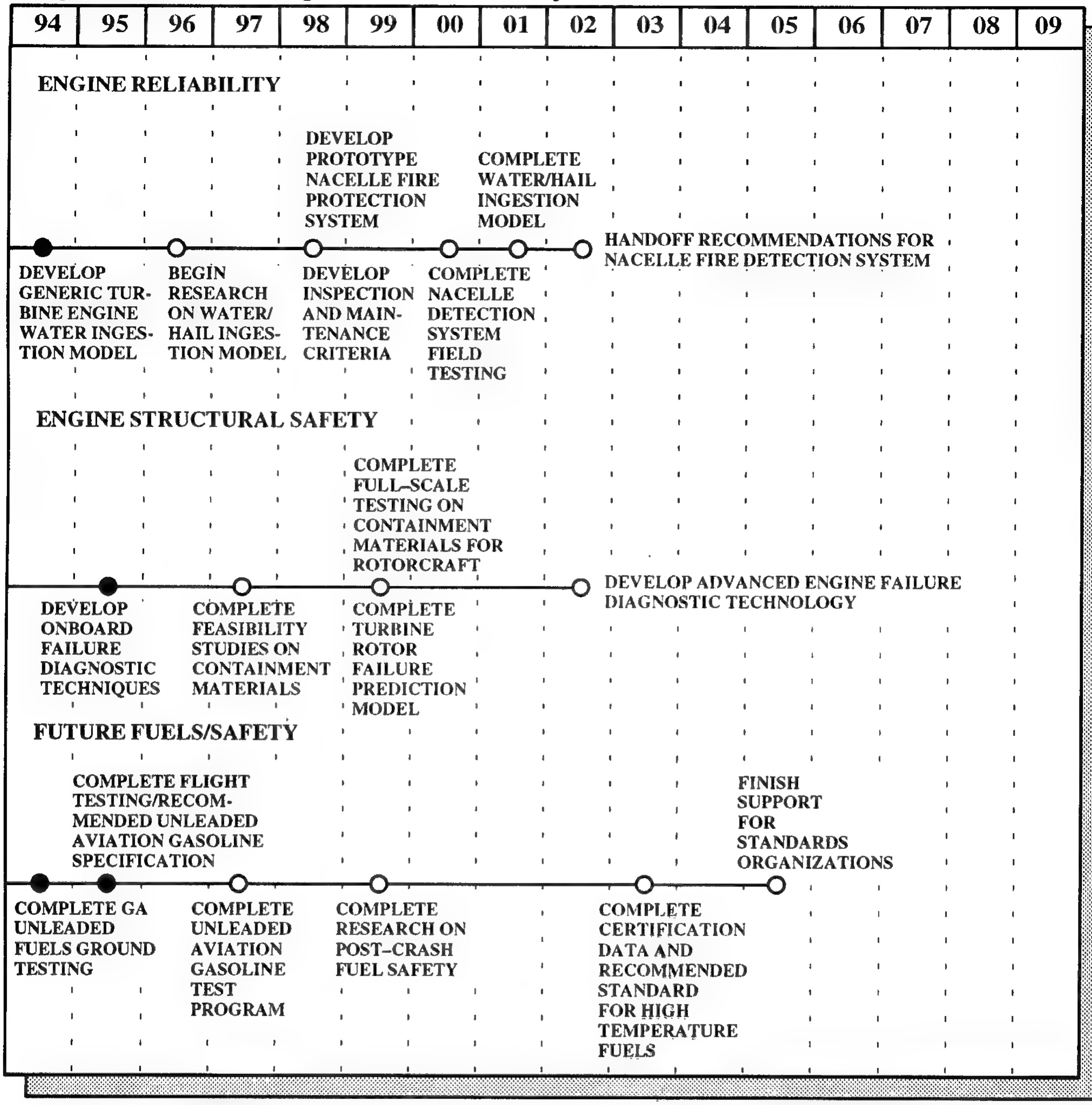
Engine Structural Safety

In–service turbine engine rotor failures will be continuously analyzed and engine failure reports published annually. Feasibility studies to develop and evaluate lightweight containment materials will be completed in 1997, with full–scale testing for rotorcraft applications being completed in 1999. The materials under consideration include composite weaves, ceramics, and advanced metallics. Work on developing advanced engine failure diagnostic technology using artificial intelligence and in–situ engine inspection techniques will be completed in 2002. An analysis currently in progress will produce an analytical model of rotor failure fragmentation patterns in 1996, with model validation expected in 1999.

Future Fuels/Safety

In 1996, procedures and software on octane requirements and engine knock characteristics will be available for industry use. The unleaded aviation gasoline test program will be completed in 1997, and certification support will continue through 1999 when a new specification is expected from the American Society for Testing and Materials. In 1998, recommendations will be completed on certification standards for general aviation fuels. From 1996–1999, research will investigate approaches to improve post-crash fuel containment. A new research initiative will begin in 1998 to investigate the effects of high temperature on fuel stability, aircraft safety, and engine performance. Research on this effort will conclude with certification data and recommendations for standards in 2003, followed by support to standards organizations through 2005.

Project 063–110: Propulsion and Fuel Systems



064–110 Flight Safety/Atmospheric Hazards

Purpose: This research has the potential to identify safety problem areas before accidents occur. This project will address new digital technology as well as design and operational issues associated with atmospheric hazards, both natural and manmade, to provide technical data,

guidelines, advisory material, and procedures for the regulatory and certification process.

Approach: This project comprises four areas: aircraft icing, electromagnetic environments, digital systems validation, and flying qualities and operations.

Aircraft Icing

This project addresses both in–flight icing and ground deicing issues. Efforts will focus on screening and assessing commuter–class aircraft with potential susceptibility to icing-induced tail-plane stalls (ICTS). Flight test procedures that facilitate assessing new aircraft susceptibility to ICTS will be developed, leading to certification testing guidelines.

Surface ice detector(s) and related technologies will be assessed, leading to prototype systems for evaluation. In cooperation with NASA and the Department of Defense, analytical techniques and simulation methodologies will be developed for designing and testing ice protection systems. Technologies associated with current and advanced ground anti/deicing fluids will be investigated to determine optimal application procedures, holdover-time guidelines, and associated aerodynamic effects. Analysis of the worldwide aircraft atmospheric icing environment data will continue and will include snow, ice crystals, freezing precipitation, and mixed conditions along with the super-cooled cloud analysis completed earlier.

Electromagnetic Environment

This project will conduct research to determine the adverse effects from lightning and high intensity radiated fields (HIRF) on all advanced technology airframes and systems. Efforts will focus on developing data bases that support electromagnetic analyses for HIRF and lightning, and the results will be regularly disseminated at international symposiums. A cooperative effort will be conducted with the United Kingdom to develop lightning and high energy static charge protection standards for radomes and farings. Tests on radomes and aircraft materials/components will validate the new standards. Lightning strike incident data will be gathered from participating airlines and analyzed to determine the effects from incorporating composite materials and highly sensitive electronics in aircraft. This project will determine the most reliable and cost effective techniques for certifying flight critical systems. Analysis and testing will be conducted in an effort to correlate modeling techniques with full-scale testing results.

Digital Systems Validation

The digital systems validation research will compare and address existing airworthiness/certification standards and techniques with advanced fly–by–wire (FBW) and fly–by–light (FBL) digital flight control and avionics systems concepts. Emphasis will focus on safety issues concerning flight critical systems applications. This project will evaluate current system safety assessment methods and modify or develop new techniques as required. These techniques will be used to assess fault tolerant architectural design methodologies for both hardware and software. An electromagnetic effects assessment associated with FBW/FBL and the new power–by–wire concepts will also be addressed. This work will be accomplished in coordination with NASA.

Flying Qualities and Operations

The flying qualities area will address certification issues related to improved flight safety assessments for new aircraft that use advanced displays, flight management systems, procedures, and modified operational profiles.

Related Projects: 022–140 General Aviation and Vertical Flight Technology Program and 066–110 Aircraft Catastrophic Failure Prevention Research.

Products:

- Pilot's Guide to Aircraft Ground Deicing Advisory Circular (AC)
- Report on field measurements for advanced anti/deicing fluid time of effectiveness
- Report on validating analytical technologies, computer codes, and simulation methodologies
- Electromagnetic threat definition, development, and validation
- Lightning AC and user manual updates
- HIRF AC and user manual updates
- Digital systems validation handbook update
- Report on flight critical digital systems technology studies for airworthiness certification
- Software development guidelines report and data package
- Data to support operational procedures development for advanced rotorcraft/ tiltrotor instrument flight rules approaches to heliports
- Aircraft surface ice detection technologies and systems.

1995 Accomplishments:

- Complete research on current anti/deicing fluid time of effectiveness for various freezing precipitation conditions.
- Evaluate an optical–based aircraft surface ice detector technology.
- Complete full authority digital engine controller testing in a production helicopter.
- Develop new lightning protection fuel tank standard for use in certification.
- Complete the FAA research and development electromagnetic database.
- Publish three chapters of the HIRF handbook.
- Publish Digital Systems Validation Handbook – Volume III, Chapter 1.
- Publish technical report on software performance service history for certification specialists.
- Complete FBL fiber optics technology assessment for FBL/power-by-wire digital flight control and avionics systems concepts.

Planned Activities:

Aircraft Icing

In 1996, efforts will continue on developing analytical tools and simulation models that will assess aircraft design susceptibility to ICTS. In 1996, flight test procedures will be completed on ICTS susceptibility. Analysis and development work on aircraft surface ice detection technologies will continue through 2001. The technologies investigated will include: infrared and radar from 1996–1998, near–infrared from 1996–1999, visible light through 1998, ultrasonic from 1997–1999, and acoustical technologies from 1997–1999. In 1999, a decision will be made on which technology to develop into a surface ice detection area coverage system for implementation in 2001.

In 1996, new and advanced deicing fluids will continue to be evaluated for their time of effectiveness and their aerodynamic performance. These evaluations will lead to updated holdover-time guidelines in 1998.

In 1996, anti–icing research in this project will focus on advanced ice protection technologies such as ice shedding materials and coatings, and low energy anti–icing techniques. An important product in 1997 will be a technical report on icing-induced tailplane stalls and the interrelation of variables that cause or contribute to these stalls. Design material to preclude this phenomenon will be provided. In 1997, in conjunction with NASA, analytical codes will be developed for use on rotorcraft and small airplanes. Ice protection systems are planned for 1998. In 1999, both aircraft-mounted and handheld surface ice detectors with localized coverage will be developed. Further research will lead to publishing advisory material to facilitate icing certification of small airplanes and rotorcraft in 2000, and developing universal coverage surface ice detectors in 2001.

Additionally, newer aircraft such as tiltrotor/powered–lift, supersonic transport, and the national aerospace plane will require innovative ice protection technologies and attendant innovative approaches for certification. This project will conduct research on powered–lift vehicle (PLV) icing systems, leading to a validation report in 2004. In 2007, a PLV icing technical report will be issued based on flight testing.

Electromagnetic Environment

In 1996, the advisory material and user manuals will be updated to support aircraft certification requirements for HIRF and lightning protection. New data sources will be evaluated in 1996 and incorporated, as necessary, into the rulemaking process. Also in 1996, research from this project will be presented to the international community at a symposium in Williamsburg, Virginia.

In 1996, HIRF systems tests will be completed, and a technical report on full–scale testing model validation will be issued in 1997. Also in 1997, HIRF flight control/avionics protection standards will be published. Subsequent research will address HIRF and lightning issues in advanced aircraft. In 2002, full–scale PLV HIRF and lightning tests will begin. These tests will lead to a technical report on HIRF and lightning in 2004. Further research will be conducted in 2007 for fly–by–light critical function validation.

Digital Systems Validation

In 1996, research will proceed on assessing fault tolerant architecture and electromagnetic effects. The Digital Systems Validation Handbook – Volume III will be expanded to include a chapter and a tutorial on certification issues for highly complex digital devices. Technical information on FBW and FBL systems will be compiled for evaluations to develop advisory material on FBL systems in 1998. Additional advisory material will be published in 2000 for rotorcraft FBW/FBL systems. Fault tolerant data bus architectures for FBW/FBL will be evaluated as well. Advisory material will be published in 1999 on Aeronautical Radio, Incorporated (ARINC) 429/629 bus fault tolerance and in 2001 on MIL–STD–1553B data bus fault/failure modes.

In 2004, validation techniques will be developed for PLV systems, and in 2005, the Digital Systems Validation Handbook – Volume IV will be published.

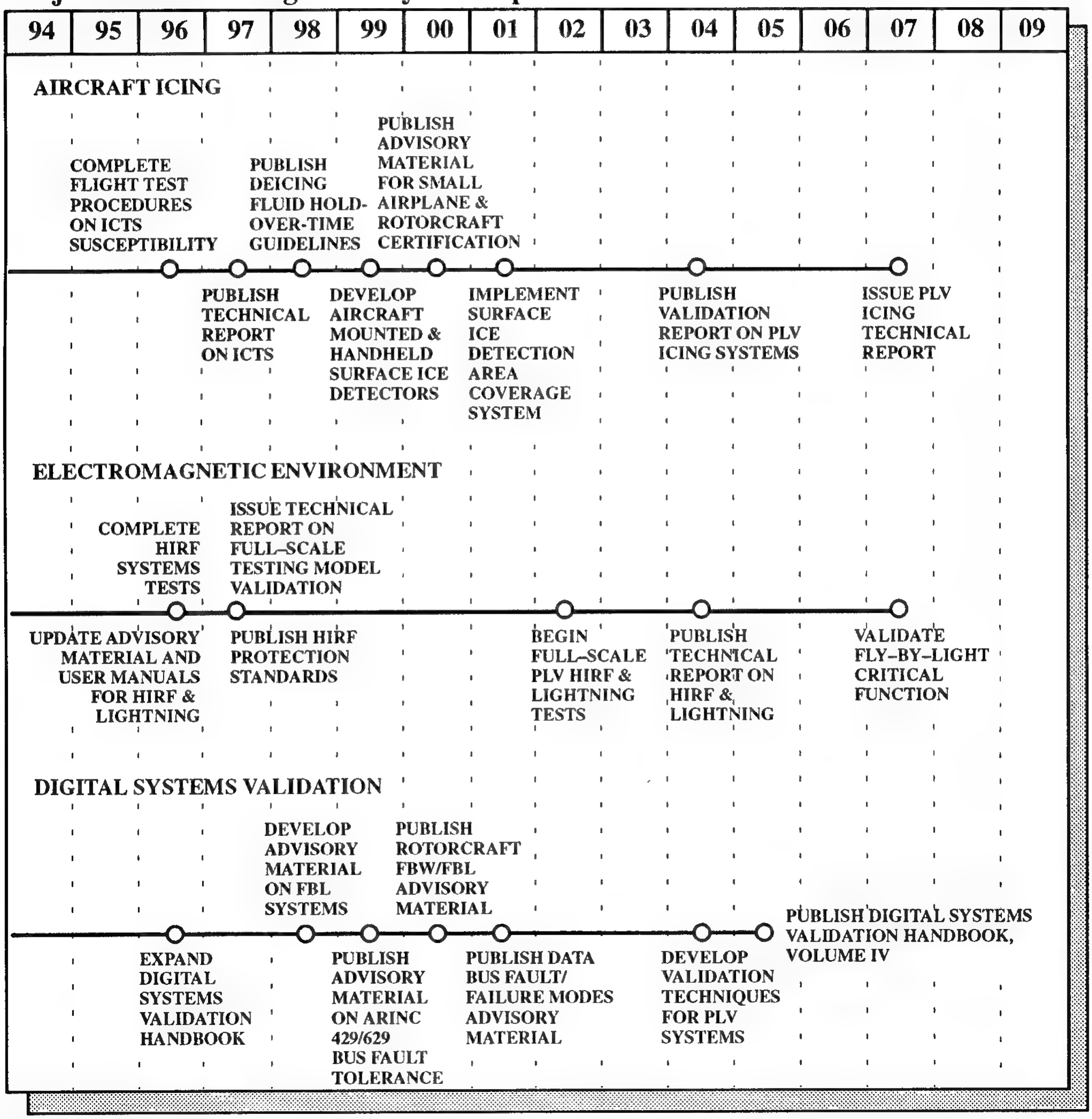
Flying Qualities and Operations

In 1997, technical emphasis will concentrate on updating flight test data and analysis of FBW automated flight control systems and equipment that improve safety and certification techniques. Both type– and operational–certification issues will be addressed for failed–mode flight conditions as well as normal operations. Also, during 1997, work will continue to provide solutions and

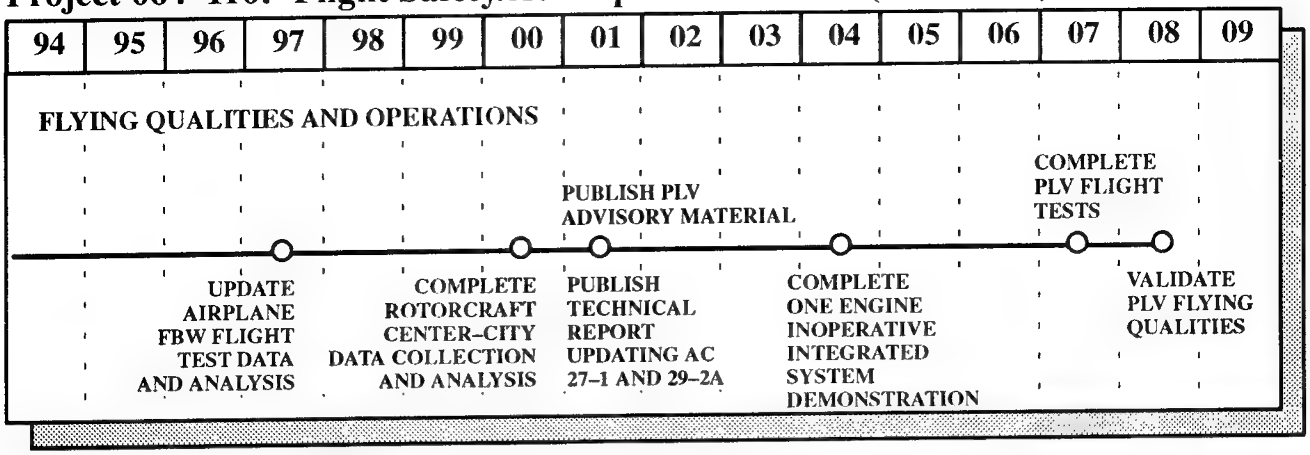
alternatives for improved access and more efficient use of center–city heliports by rotorcraft. In 2000, data collection and analysis will be completed on the effect of instrument meteorological conditions on center–city rotorcraft operations.

In 2001, a technical report will be issued to update Advisory Circular 27–1 and 29–2A. Also, advisory material for PLV flying qualities and operations will be published. In 2004, a one engine inoperative integrated systems demonstration will be conducted. In 2007, civil PLV flight tests will be completed for flying quality validation in 2008.

Project 064–110: Flight Safety/Atmospheric Hazards



Project 064–110: Flight Safety/Atmospheric Hazards (continued)



065–110 Aging Aircraft

Purpose: Aging airframe structures have shown increasing susceptibility to widespread fatigue damage and corrosion that could pose a threat to their structural integrity. Instances of structural failures point to the need for increased reliability in inspection methods. Furthermore, the demands on the aviation safety inspectors due to the aging aircraft fleet require automated data tracking improvements. This research effort will develop the means for evaluating and ensuring safety and reducing the risks associated with aging aircraft structures. The three thrust areas of this project are: structural design, maintenance and inspection, and automated methods for surveillance of information relating to the aging aircraft fleet.

The various research activities will also include technology transfer of technical material and knowledge to industry and foreign regulatory agencies.

Approach:

Structural Integrity

To address aging aircraft structural design problems, improved methodologies and test data are needed. Models and data will be developed to correlate service experiences with test and analysis results. Design alternatives that delay or eliminate widespread fatigue damage will be identified.

The corrosion effects on fatigue and fracture will be quantified and evaluated. Analytical fracture models resulting from this work will be used as a basis for rulemaking.

Means for evaluating the effect of single and multiple repairs on airframe structural integrity will be developed. This work will benefit independent repair stations and smaller air carriers. Modern flight and ground load data collection systems will be developed, and the structural loading histories will be determined for the current fleet.

Maintenance and Inspection

Improvements in maintenance practices and training, as related to repair and corrosion control, will be developed and offered to heighten awareness of structural degradation modes among the aviation community, particularly the aviation maintenance technicians and inspectors. A job task analysis will be conducted to identify critical maintenance and inspection tasks and establish a basis for training updates.

Existing and emerging nondestructive inspection (NDI) equipment and methods will be evaluated in relation to their capability to detect structural defects. Prospective technologies are being developed that offer improvements in relation to detectability, reliability, ruggedness, automation, human performance, and cost. Prototype systems will be developed and tested for the most promising technologies leading to cooperative research and development agreements with industry for technology transfer. Additionally, standards will be developed for inspection facilities, equipment, and personnel.

Information Systems

In this thrust area, safety analysis and data management systems will be developed. These systems will be designed to audit critical performance indicators, identify safety risks, and maintain information for certificate holders approved by the FAA. Specifically, these systems will have the capability to interrogate data relating to air operators, aircraft type, air agencies, and air personnel.

Related Projects: 062–110 Advanced Materials/Structural Safety, 063–110 Propulsion and Fuel Systems, 064–110 Flight Safety/Atmospheric Hazards, 066–110 Aircraft Catastrophic Failure Prevention Research, and 085–110 Aircraft Maintenance Human Factors.

Products:

- Damage tolerance training materials for FAA certification personnel
- A maintenance and inspection management program for commercial pressurized engine cases that will be used to derive regulatory documents
- Analytical tools and models to assess commuter and transport aircraft structural integrity and repairs
- Technical data used to formulate the Special Federal Airworthiness Regulation and advisory circulars on widespread fatigue damage and the corrosion fatigue interaction
- Technical data for flight and ground loads encountered by transport and commuter airplanes that can be used for design and certification
- Training tools, aids, and material for repair, maintenance, and inspection personnel
- Advisory circulars on airframe maintenance, repair and corrosion control procedures, and aircraft engine testing
- Inspection systems for flaw detection in airframe structures and engines for compliance certification
- Safety performance analysis system (SPAS) to assist aviation safety inspectors in identifying certificate holders that present an excessive safety risk

1995 Accomplishments:

- Develop analytical models to account for corrosion fatigue interaction in aircraft fuselages and to predict widespread fatigue damage.

- Develop an analytical tool for designing and analyzing airplane fuselage skin repairs.
- Collect landing/flight load data and published technical report.
- Develop a corrosion control program for commuter aircraft.
- Develop parameters for aircraft turbine engine component inspection systems.
- Release SPAS.

Planned Activities:

Structural Integrity

In 1996, full–scale aircraft panels will be tested to determine multi–site damage effects on residual strength, and residual strength predictive methodologies will be validated. In 1997, methodologies will be developed that predict widespread fatigue damage. These methodologies will be integrated into an overall risk assessment methodology in 1998. In 1999, the analytical methodologies will be extended to structural modifications and corrective actions.

In 1996, factors affecting fatigue and airframe design fracture resistance will be studied, leading to design guidelines in 1997. In 2000, research will be completed on a tool that designs and analyzes repairs to complex metal aircraft structures.

From 1996–2000, development work will be conducted on a global risk analysis model that predicts aircraft service life. A prototype will be developed in 1998 for testing and evaluation through 2000. Residual strength research will be completed in 2003 when the various structural models are validated and made available for industry use.

In 1996, a data base for aircraft engine materials will be developed to formulate crack growth-based methodologies. The methodologies will be developed by 1998 to derive inspection and maintenance requirements for engine pressurized static cases. These methodologies will be tested and validated in 1999 at which time engine life prediction research will be completed.

From 1996–2003, flight and ground loads data collection will continue for structural analysis programs. A European video landing parameter survey will be completed in 1996 with an additional survey completed in the United States in 1997. A methodology will be developed in 1997 for structural design and fatigue loads on small airplanes. This methodology will be validated in 1999 and refined for industry use in 2000. In parallel with the small airplane fatigue load research, a methodology will be developed for transport category aircraft. This methodology will be developed by 1999 and validated by 2002 for industry use in 2003. This effort will complete research on flight and ground loads.

Maintenance and Inspection

In 1996, a prototype PC–based repair tool addressing aircraft structural modifications will be developed. This tool will be evaluated from 1997–1998 for field implementation in 1999. Additionally, an updated advisory circular will be developed in 1996 on repair procedures for commuter aircraft. A corrosion handbook for commuter aircraft operators also will be published. In 1997, corrosion control products will be evaluated. Specifications will be developed for composite-to-metal repairs in 1997, with repairs analysis planned for completion in 1999.

In 1998, repair station housing/equipment criteria will be developed for airframe and engine structural repairs. Additionally, an advisory circular on engine test cell data correlation will be completed to eliminate anomalies between individual repair stations.

In 1996, weighted job task definitions will be developed for aviation maintenance technicians. This research will lead to developing aviation

specialist qualifications and standards in 1998. Research on validating and assessing inspection techniques will continue through 2004 at the Aging Aircraft Nondestructive Inspection Validation Center. A corrosion detection prototype device will be developed in 1996 for evaluation through 1998. A prototype device for crack detection will be developed in 1997 for evaluation through 1999. A prototype device to detect aircraft skin debonding will be developed in 1998 for evaluation through 2000. As evaluations are completed on these prototypes, field systems will be implemented for industry use by 2004.

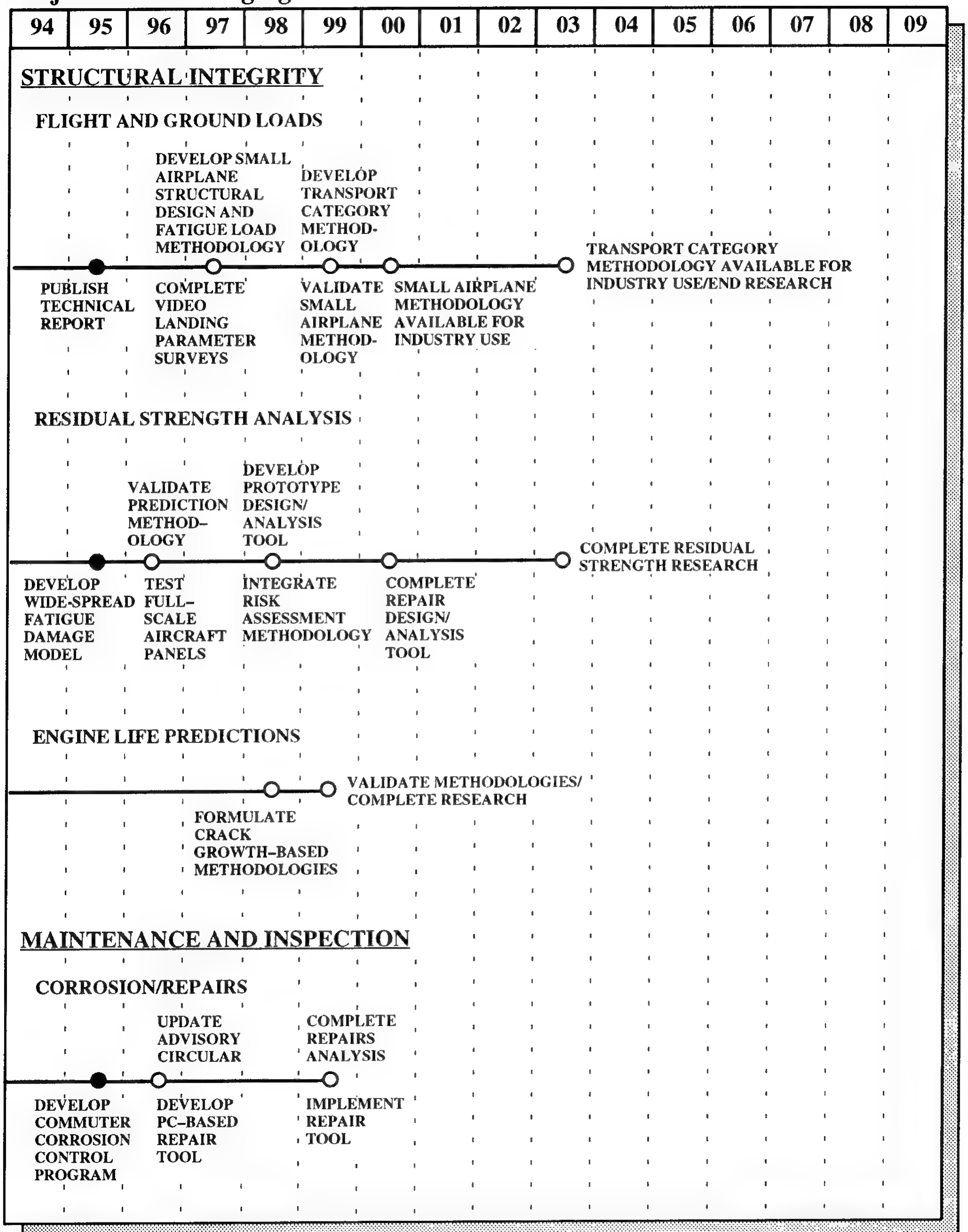
In the engine inspection area, a prototype eddy current array probe and a portable eddy current scanner for in–service engine component inspection will be completed in 1996. Ultrasonic methods for inspecting engine material and components during production will be developed in 1997 and validated in 1998. Also in 1998, research will begin on developing fluorescent penetration inspection improvements that will detect smaller flaws with greater reliability. These techniques will be evaluated through 2004 to test their reliability. The fluorescent penetration inspection improvements will be approved for industry use by 2007.

Information Systems

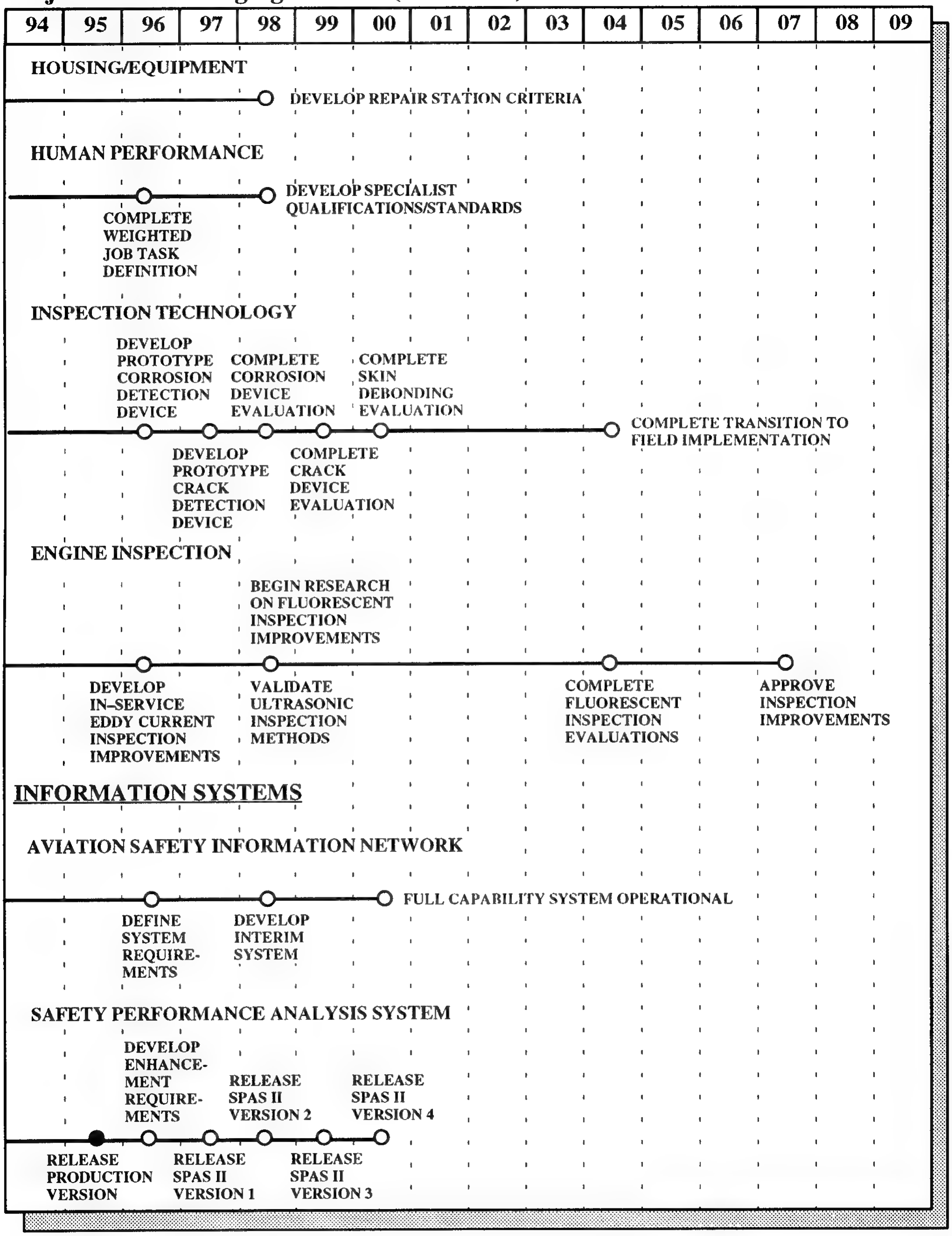
In 1996, research efforts will continue on developing an aviation safety information network that will use the available FAA infrastructure and commercially available networks. This safety network is required for information transfer between the FAA and industry. System requirements will be defined in 1996, followed by an interim operational system in 1998. This interim system will be evaluated in 1999, leading to a fully operational system in 2000.

In 1996, development work on risk assessment and information display capabilities will continue. Critical performance indicators to support both flight standards and air certification personnel will be developed, tested, and implemented into analytical systems such as SPAS. In addition, SPAS and other flight standards and air certification systems will be continually enhanced with artificial intelligence, expert system, and advanced graphics capabilities. The first system to be influenced with these capabilities will be SPAS II, scheduled for release in 1997, with enhanced versions scheduled for release in 1998, 1999, and 2000.

Project 065–110: Aging Aircraft



Project 065–110: Aging Aircraft (continued)



066–110 Aircraft Catastrophic Failure Prevention Research

Purpose: This project will establish and direct a research effort with the objective to identify, reduce, and prevent aircraft system problems that could result in a catastrophic aircraft failure. This failure prevention research will reduce catastrophic accident risks and the number of hull losses, injuries, and fatalities. Information developed from this project will be disseminated to the aircraft industry on a regular basis. This research is required by Title IX of the Omnibus Budget Reconciliation Act of 1990 (Public Law 101–508), "Aircraft Catastrophic Failure Prevention Research Program."

Approach: This project will conduct research to develop methodologies that characterize and assess the risks associated with potentially catastrophic aircraft hardware and software problems. Then, technologies will be identified to prevent or minimize these hazards. Centers of Excellence will be established at universities and/or nonprofit national research laboratories as research focal points. The research will concentrate on three individual technical areas: turbine engine/auxiliary power unit failure hazards prevention, fuselage structural failure prevention, and damaged/failed flight control system airworthiness.

Turbine Engine Failures

A failure in turbine engine and auxiliary power unit rotating components can be a serious safety hazard to critical aircraft systems because high energy fragments can be released. The traditional approach to minimize these hazards is to isolate individual engines and APU's from other engines and flight critical systems. More effective containment or protective shields are an under utilized approach due to weight and complexity penalties. This project will develop high energy fragment containment and/or protective shield material technology. A comprehensive, advanced lightweight material technology state–of–the–art review will be conducted, and new material concepts will be developed for absorbing high kinetic energy fragments in the largest turbofan engines. Further efforts will provide a methodology to determine catastrophic failure probability and risk assessment. This methodology will be used to develop an analytical model of liberated fragments from gas turbine engine and APU rotating components. This model will assist in assessing the catastrophic failure risk in current and future designs.

To reduce the occurrence of rotating component failures, advanced computational technology will be used to develop expert, neural network, and artificial intelligence systems. These systems will monitor, acquire, and interpret parameters to predict and trend rotor system abnormalities or impending failures. Sensor technology will be developed to measure critical parameters. This capability will be integrated into a total aircraft parameter monitoring system. In addition, research will be applied to advanced critical engine rotating part material, design, life management manufacturing, and inspection technologies. A turbine engine titanium consortium is continuing to evaluate and improve state-of-the-art NDI technologies.

Structural Failures

Research will be directed toward advanced means to predict and prevent catastrophic structural failures on future commercial transport aircraft. Emphasis will be placed on: forming accurate, quantitative definitions of dangerous aircraft loading conditions; structural failure prevention through improved airframe design and maintenance; and structural failure survivability through an improved understanding of failed airframe loading conditions.

An effort will be undertaken to develop a vulnerability assessment for wide- and narrow-body transport aircraft. Advanced analytical and computational design tools and concepts will be

developed and applied to future airframe system designs. Automated maintenance/inspection monitoring devices and artificial intelligence training systems will be developed, tested, and implemented. Interagency agreements will be established for determining composite component structural quality and composite/advanced component inspection and repair procedures.

Flight Control Failures

This project will address specialized technology fields that concentrate on preventing catastrophic flight control failure after an in–flight accident or incident. Research will assess what failed–mode flight control options are practical for any control failure case to ensure continued safe flight and landing. This project will concentrate on studies that include areas such as: substitute, alternate, and reconfigurable control systems; flying qualities criteria; stability and control; situational awareness; and human factors. A program of modeling analysis simulation and variable stability aircraft flight tests is planned to provide technology that could be beneficial in failed–mode flight control situations. The proposed approach will test both aerodynamic aspects and aircraft stability and control. This approach will: develop technology to improve aircrew emergency procedures; provide aircrew training that simulates damaged aircraft handling qualities; conduct research on damaged flight control airworthiness issues; and provide a real–time flight control cockpit advisory system.

Related Projects: 062–110 Advanced Materials/Structural Safety, 063–110 Propulsion and Fuel Systems, 064–110 Flight Safety/Atmospheric Hazards, 065–110 Aging Aircraft, and 075–110 Aircraft Hardening.

Products:

- Full–scale prototype aircraft diagnostic system(s)
- Advanced containment material(s) suitable for airframe and/or engine applications
- Advanced airframe and engine structures maintenance, inspection, monitoring, and advisory systems
- New NDI inspection technologies for advanced engine and structural materials
- Aircrew emergency procedures and new systems for damaged or failed flight control systems
- Failure modes risk assessment analysis methodology tools
- Computational models of airframe loads during impact or depressurization scenarios
- Quantification and analysis of gust loading conditions on transport aircraft
- Failed-mode flying qualities assessment system and situational awareness/cockpit resource management procedures

1995 Accomplishments:

- Complete phase I of the NASA/FAA joint flight simulation program on propulsion-controlled aircraft.
- Complete analytical study of uncontained turbine rotor fragment penetration threat to aircraft wing fuel tanks.
- Develop an advanced turbine rotor fragment barrier material concept.
- Complete rotorcraft health and usage monitoring systems (HUMS) flight demonstration.

Planned Activities: Completion of the aircraft failure threat definition studies in 1996 will lead to developing a prototype risk assessment methodology for demonstration in 1998. This methodology may be used as a tool to analyze cascading failures originating from turbine engines aircraft structures and/or flight controls to assess the secondary damage effects. Results from the prototype methodology will be a basis for directing this project's future research initiatives. From 1998 to 2001, the prototype methodology will undergo validation and refinement. In 2002, the refined methodology will be available for regulatory agencies and industry to consider as a standard.

Turbine Engine Failures

In 1996, integrated aircraft engine diagnostic system research will be initiated to develop a prototype for integration testing and demonstration on an operational aircraft by 2000. In 1996, a prototype computational model will be developed to simulate rotor fragment dispersal, barrier penetration, and aircraft damage. Model validation will take place through 1998, with final development expected by 2000. In 1996, a technology review will be completed, followed by a development effort on candidate fragment barrier concepts. An advanced barrier materials report will be published in 1998.

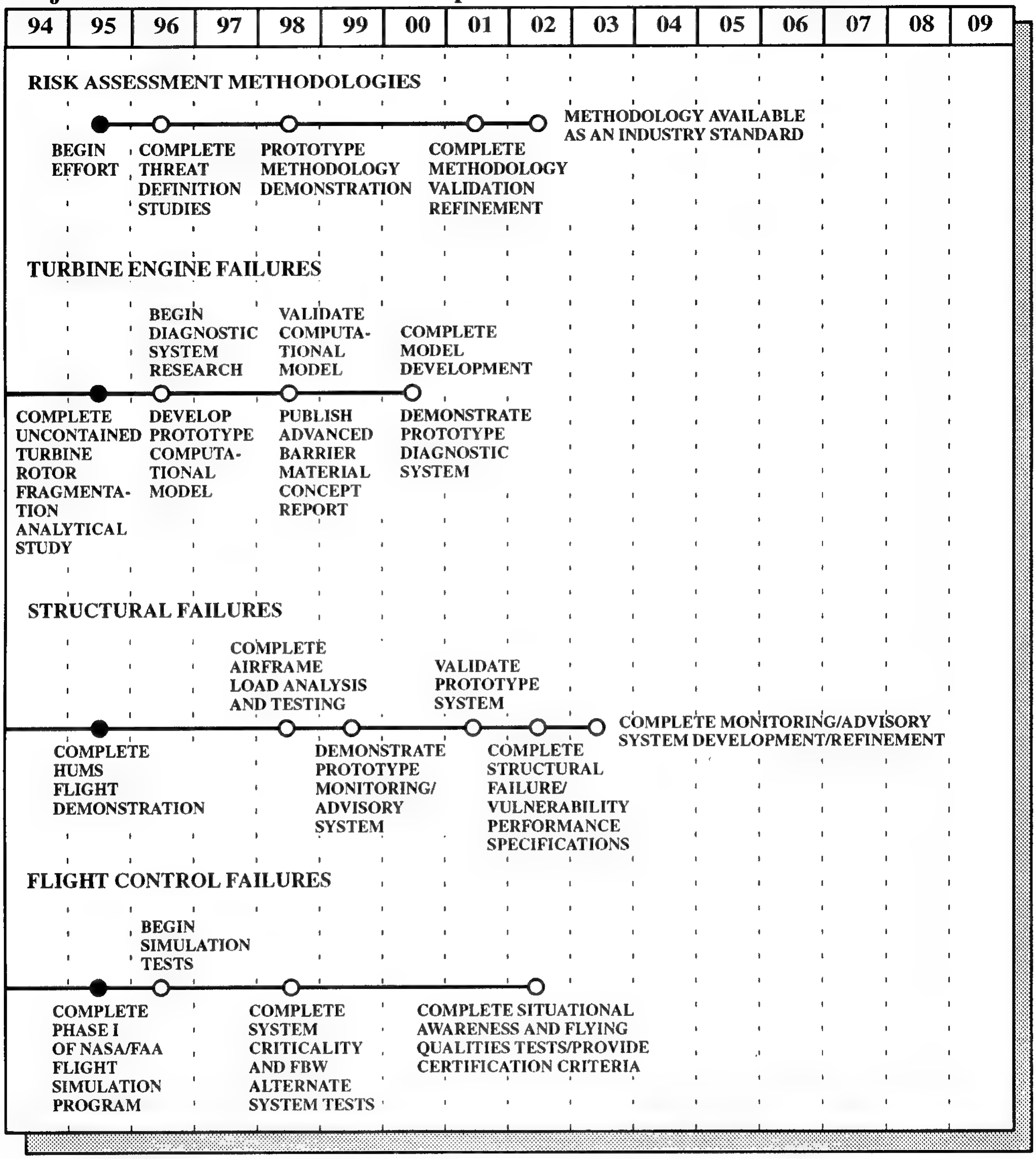
Structural Failures

Contemporary and future airframe load analysis and testing will continue through 1998. Structural failure vulnerability reduction through design improvements and new repair and inspection specifications will be ongoing through 2002. The advanced damage tolerant structure design and smart structure research will continue through 1998. A prototype airframe maintenance inspection and fault monitoring/advisory system demonstration will be conducted in 1999. The prototype system will undergo validation through 2001, followed by final development and refinement by 2003.

Flight Control Failures

In 1996, continued research will assess the viability of failed–mode flight control options for emergency operational conditions. In 1996, simulation tests will be initiated related to failed-mode flight control system criticality and fly-by-wire alternate flight control architectures with completion expected in 1998. Data from these tests will be given to appropriate regulatory agencies to develop advisory material in 1999. Situational awareness and flying qualities assessment issues relative to failed-mode flight control will be addressed during 1997–2002. This effort will provide agency flight test pilots with type- and operational-certification criteria for failed-mode flight in 2002.

Project 066–110: Aircraft Catastrophic Failure Prevention Research



067–110 Fire Research

Purpose: The Aviation Safety Research Act of 1988 requires the FAA to conduct long–term fire safety research to eliminate fire as a cause of fatalities in aircraft accidents. This project will investigate new technologies to improve fire safety for current and future aircraft. Research will develop fire–safe cabin materials, smart systems for aircraft fire hazard control, new techniques for fire suppression, and low flammability safety fuels.

Approach: This project will focus on six interrelated research areas: fire modeling, vulnerability analysis, fire–resistant materials, improved systems, advanced suppression, and fuel safety. Research in all these areas must be accomplished to satisfy the overall goal of making a fire–resistant cabin.

Fire Modeling

This project will develop computer models to predict the initiation and growth of in–flight and post–crash fires. These models will have the flexibility to create virtually the entire range of accident scenarios and will identify critical performance requirements for aircraft materials and systems. The models will undergo a validation process that compares the model results against full–scale test results and updates the modeling techniques as needed.

The modeling effort will provide the basic tools for an aircraft fire risk and vulnerability analysis with a resulting technology that can be used to predict the safety of a given aircraft design. This technology has direct application to both in–flight and post–crash fire threats. Employing the aircraft fire analysis tools will identify weak links that increase vulnerability to fire. These weak links will show where improvements are needed in existing materials, structures, or systems. Identifying shortcomings in cabin material flammability properties could lead to a specification that would make the aircraft interior totally fire resistant in accidents. Other weak links might be in design deficiencies that can be cured by applying new fire protection systems. The analytic tools can also provide the capability to determine when fire safety improvements reach the point of diminishing returns.

Vulnerability Analysis

In–flight fire vulnerability research can show what systems are most likely to cause a fire, what systems are likely to fail in a fire, and what fire scenarios are most likely to have catastrophic results. The conditional probability of a catastrophe then provides a basis for estimating fire safety of a given aircraft design. The relative magnitudes of the individual probabilities can be used to identify the design features, systems, and materials where improvements will be most beneficial.

Probabilistic statistical techniques will be used to identify the likelihood of different post–crash fuselage breakup configurations with varying terrain and weather conditions. These scenarios will be used to establish performance requirements of mathematical fire models.

Fire–Resistant Materials

Three primary approaches will be followed for developing material systems for a fire–resistant aircraft cabin. The first approach will be to reduce flammable gas production by formulating materials that break down into char or a thermally stable chemical structure. The second will be to develop material systems that will release fire suppressants when heated. The third will be to develop assemblies that involve insulation and reflective coatings to delay fire spread. The performance requirements for all of these new fire–resistant materials will be provided by fire modeling and vulnerability analyses.

Advanced material research will require determining the fundamental relationships between material composition and behavior in aircraft fires. To determine these fundamental relationships, the project will employ molecular modeling to predict fire test performance of new fire–resistant materials. This modeling will provide the basis for synthesizing new materials and developing new combustion and structural response models that can be used in aircraft materials design.

Improved Systems

Research in this area will focus on eliminating electrical and mechanical devices as fire causes, as well as assuring the continued functionality of critical systems when exposed to fire. Other research will investigate improvements such as better resources to aid the flight crew and means to minimize occupant hazards.

The project will use results from vulnerability analyses and fire modeling to identify which systems are most vulnerable from exposure to fire or smoke. Improved systems will be developed based on these analyses. Highly sensitive and gas–specific sensors, coupled to artificial neural networks, will be used to develop more reliable and timely fire warning systems. Fire modeling of in–flight fires will lead to improved techniques for cabin smoke control and removal.

Advanced Suppression

Existing aircraft fire suppression systems are based almost exclusively on trial and error development. This project's long–term basic research will close technology gaps by providing a fire suppression science. Research will focus on disrupting high temperature chemical reactions in material combustion through models and simulations.

In parallel with the basic research, the project will evaluate new technologies such as gas membranes to provide a realistic onboard inert gas generating system (OBIGGS) as an alternative approach for fire suppression. Further research will examine material combinations that release suppression chemicals when heated. Synergistic effects will be sought which will allow developing hybrid suppression systems.

Fuel Safety

Research in this project will focus on fuel additives that can affect fuel flow behavior, breakup characteristics, vaporization, and surface characteristics. Fuel safety improvements will be developed using a variety of chemical ingredients that change the mechanical or chemical behavior of fuel released in an aircraft crash. Studies will focus on finding additives that make fuel ignition less likely or that reduce the fuel energy release rate when ignition does occur. Modeling and experiments will be used to find the parts of the fuel burning processes where additives will have the most effective impact. Based on research results, additive formulations will be developed to optimize their effectiveness in reducing fuel fire threats.

Related Projects: 061–110 Aircraft Systems Fire Safety, 062–110 Advanced Materials/Structural Safety, 063–110 Propulsion and Fuel Systems, and 066–110 Aircraft Catastrophic Failure Prevention Research.

Products:

- Computer fire codes predicting hazards to passengers and damage to aircraft systems
- Probabilistic risk assessment methods for objectively evaluating fire risk associated with specific aircraft designs, systems, and procedures
- Totally fire-resistant materials for fabricating aircraft cabin interiors
- Aircraft design features to reduce inherent fire risks

- Fire suppression systems
- Fire and smoke detectors employing neural networks to eliminate false alarms
- Fuel additives that reduce the intensity of post–crash fuel fires
- Fuel compositions that lower spilled fuel ignition probability

1995 Accomplishments:

New start in 1995.

Planned Activities:

Fire Modeling

In 1996, existing industrial fire models will be compared for accuracy in predicting in–flight fire behavior, and a computer modeling code will be evaluated for post–crash fires. In 1997, research will be directed at code modifications to obtain more realistic results. In 1999, the models will be used to establish requirements for the fire resistant material research. Subsequently, in 2001, in–flight fire models will be available for vulnerability analysis, and in 2002, simplified risk assessment fire models will be available for the major types of in–flight fires.

In 1997, a fire model will be tested for crash scenarios without winds, followed by a wind effects model in 1999. In 2004, a fuselage burnthrough model will be coupled with this model. In 2007, a comprehensive model will be available for all major post–crash fire scenarios, and fire modeling research efforts will be completed in 2008.

Vulnerability Analysis

In 1998, an analysis will be completed to identify in-flight fire ignition sources. In 1999, the likelihood of different post–crash fuselage breakup configurations will be established. In 2001, risk and vulnerability analysis techniques will be completed for in–flight fires leading to determining required fire endurance improvements in 2002. In 2003, special fire risks associated with the high–speed civil transport (HSCT) will be identified. In 2005, a comprehensive analysis capability will be available for all in–flight fire scenarios. Vulnerability analysis research will be completed in 2006.

Fire–Resistant Materials

In 1996, work will continue on synthesizing triazine polymers and fire–resistant thermoplastics, leading to fire–resistant electrical insulation in 1998 and fire–resistant cabin lining materials in 2002. Work initiated on molecular modeling and material fire performance in 1996 will lead to an aircraft material combustion model in 2000. The results of material combustion model investigations will be used to establish a technology for fire–resistant secondary composites in 2003, and primary composites in 2006. In 2008, the technology will be completed for fire resistance of small cabin accessories presently excluded from any flammability requirements.

In 1997, work will begin on new flexible interior foam technology, leading to fire–resistant fillers for cabin accessory parts in 1999, followed by new foam insulations in 2001, and fire–resistant seats in 2004.

Improved Systems

In 1996, development will continue on a prototype smart fire detection system with completion expected in 1999. Research will also continue on a prototype cabin smoke control system for completion in 2000. In 2003, the fire endurance of all onboard critical systems will be identified. In 2005, hardening techniques for critical systems will be established, and in 2008, technology for fire–safe electrical systems will be established.

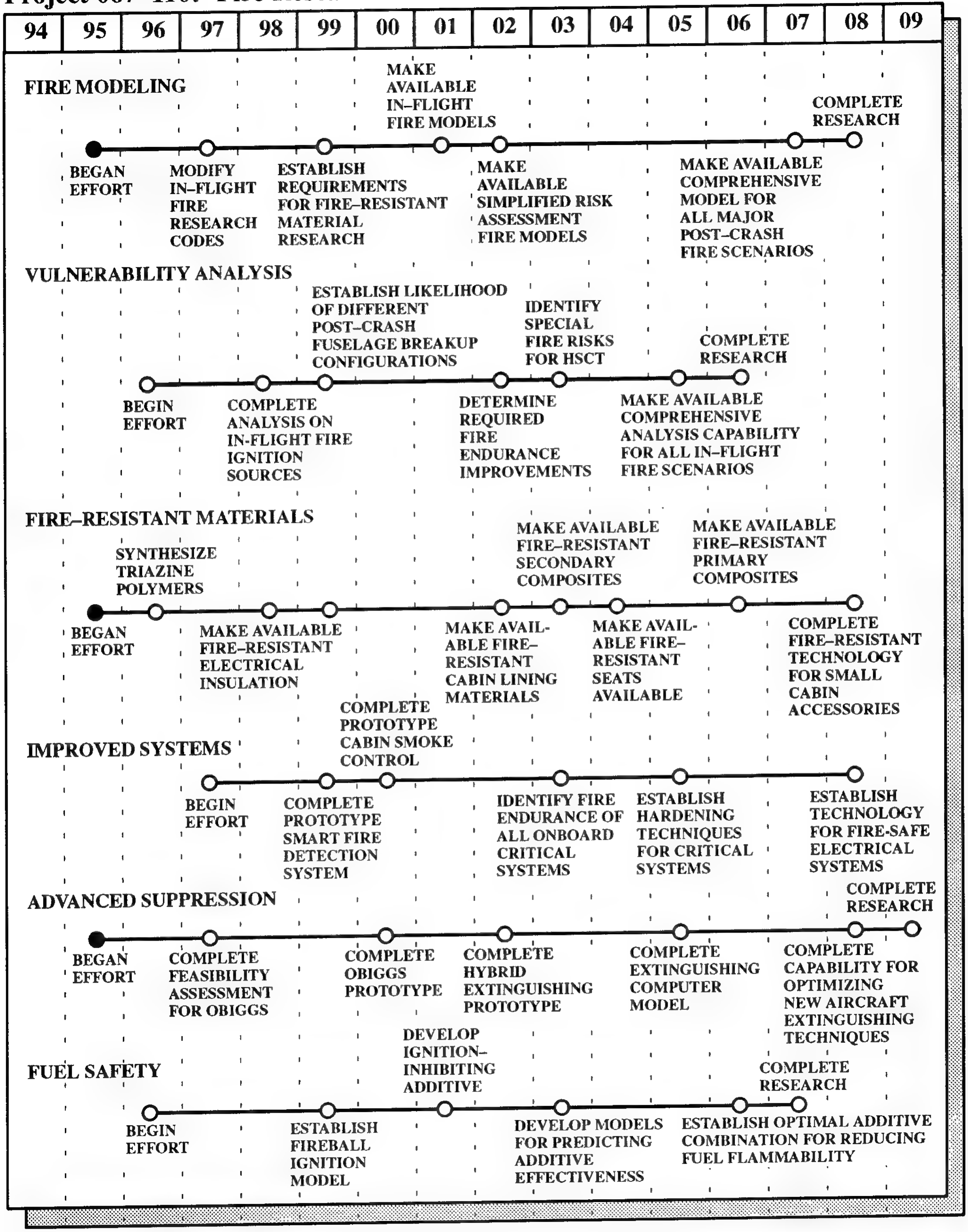
Advanced Suppression

In 1997, a feasibility assessment will be completed for an OBIGGS system with subsequent prototype completion in 2000. In 1997, work will also begin on a prototype hybrid extinguishing system. Attractive synergistic combinations will be selected in 2000, with a prototype hybrid system completed in 2002. Basic research on suppression chemistry will be initiated in 1998, and hybrid reaction characterization will begin in 2000. From these efforts, an extinguishing system computer model will be completed in 2005. In 2008, the capability will be completed for optimizing new aircraft extinguishing techniques. Research in advanced suppression will be completed in 2009.

Fuel Safety

In 1997, experimental and theoretical work will be initiated on flames propagation caused by sprays of additive–containing fuel. This work will lead to establishing a fireball ignition model in 1999 that will be used to develop an ignition–inhibiting additive by 2001. Work initiated in 1999 on additive-containing fuel burning rates will result in models in 2003 to predict how additives affect the heat release rate of large, wind-blown fuel fires. Following full–scale model verification tests during 2004–2005, an optimal additives combination will be established in 2006 for reducing fuel flammability. Research in this area will be completed in 2007.

Project 067–110: Fire Research



7.0 SYSTEM SECURITY TECHNOLOGY

This thrust area is driven by the requirement for a safe and secure aviation system. The direct benefit from an effective security system is preventing fatalities, injuries, and property losses resulting from intentional criminal acts. The indirect benefits include preventing a variety of disruptions to air traffic services and their attendant economic impact. Developing new security technologies is necessary to achieve a high security level without incurring excessive costs or inconvenience to the air transport industry or passengers.

Civil aviation continues to be an attractive target for terrorists or individuals with other criminal motives because it is highly visible. The threat level has evolved from hijacking in the mid–1970's to terrorist activities aimed at disrupting or destroying specific air transportation elements. The tragedy that befell the 270 victims of Pan Am Flight 103 over Lockerbie, Scotland, is one such act. In the United States, the immediate impact from this event was to double airline security costs from $500 million to almost $1 billion per year.

Even a threat on a specific target is sufficient to cause significant disruptions and economic impact. For example, events in the Persian Gulf during the first 3 months of 1991 reduced consumer confidence in the air transport system's security. As a result, scheduled air miles for domestic flights decreased by 5.2 percent, with international flight miles on U.S. carriers decreasing by 16.2 percent. Continued public confidence in the aviation system's security from terrorist threats, in general, and U.S. airports and carriers in particular, is key to the public using these services and the resulting economic benefits.

The Federal Aviation Administration initiatives in system security are designed to provide this confidence and achieve these benefits by developing systems that prevent or deter hijacking and sabotage. An initial thrust area assessment indicates that benefits as high as $40 million per year can be achieved from reduced airport security service costs while providing increased protection. The benefit from avoiding the direct costs of just one major incident would be approximately $150 million for a wide–body aircraft plus $450 million for the lives lost.

Research in security technology is needed to counter threats that are becoming more sophisticated. The spread of international terrorism makes it imperative for the FAA to identify and develop the most effective technologies that can be practically applied in security systems. Those who pose a threat to the traveling public are intelligent, committed, and innovative, striking where the system is most vulnerable. Protection must therefore be comprehensive, addressing all potential vulnerability in the airport and air traffic control (ATC) facilities, as well as onboard the aircraft.

The Aviation Security Improvement Act of 1990 directs the FAA to:

- Accelerate its system security program over a 36–month period;
- Expand its system security program to address current and future threats; and
- Expand the security initiatives in the aircraft hardening and human factors areas.

The continued emphasis for research in this thrust area has been on developing automated capabilities to prevent introducing explosives onto aircraft.

A broad agency announcement and solicitations for proposals have been used to identify and fund over 30 different organizations to conduct security–related Research, Engineering and Development (R,E&D). These contracting mechanisms allow the FAA to identify and

exploit innovative concepts and technologies from both industry and academia. Currently, explosive detection and pattern recognition research is underway.

The FAA's work in aviation security also involves cooperative efforts with many other Government agencies such as the Departments of State, Defense, and Energy; U.S. Customs Service; Bureau of Mines; and intelligence and law enforcement agencies. International working agreements to exchange security R,E&D information are in place with Canada, the United Kingdom, and France.

To support operational security systems deployment, the security R,E&D program includes tasks to devise standard test protocol and performance criteria for testing automated explosives detection systems and for giving advice on credible systems architecture for various detection techniques. Technology assessments will be performed on commercially developed security equipment utilizing the standard test protocol, and a list of approved automated explosives detection technologies will be developed for implementation by air carriers.

The results from the Security R,E&D Program are technologies, specifications, rules, and guidance to be used by airports and air carriers to perform their aviation security functions. The FAA does not, except for human factors and air traffic control facility protection, procure the hardware that results from the Security R,E&D Program.

7.1 System Security Technology Project Descriptions

071–110 Explosives/Weapons Detection

Purpose: This project will develop improved systems and operational procedures for detecting explosives/weapons on passengers and in checked and carry–on baggage, air cargo, and mail. These improved, fully automated systems will allow rapid passenger and baggage screening to occur without interrupting passenger or baggage flow. These systems will have high detection with low false–alarm probabilities, thereby increasing airport and air carrier safety.

The current trend in firearm and some grenade manufacturing is toward using nonmetallic components and nonferrous alloys. These weapons may escape detection by current airport metal and weapon detection systems. This project will also develop screening systems based on alternate technologies that are capable of detecting "plastic" and other unconventional weapons.

Approach:

Explosives Detection

Current systems are intrusive and labor intensive. Design goals are for systems that are fast and effective and provide a uniform, high performance level through computer assistance. The challenge is to select sensor systems appropriate to the threat and scenario, then integrate them within the constraints of an airport.

The FAA is developing two basic types of explosives detectors. The trace program is designed to collect, analyze, and identify trace amounts of different explosives, and the bulk program is designed to use electromagnetic energy or nuclear radiation to penetrate and identify bulk explosives based on their elemental or structural composition. Since they are passive devices, trace detectors are currently the only detectors that can be used for screening passengers. In the near–term, both trace and bulk prototype detectors will be developed to provide an immediate response to today's terrorist threat. In the long–term, the emphasis will be on identification, feasibility demonstration, and subsequent development of more efficient and effective new technologies.

This project will focus on three major elements for screening checked baggage: developing prototype systems, developing combined technology prototypes, and developing new detection algorithms to upgrade existing detection systems. A trace portal to screen passengers is in the development stage. Several new chemical detection technologies including mass spectrometry, surface acoustic wave, and biosensor techniques will be developed. Chemiluminescence and ion mobility spectroscopy have reached the commercial stage. The trace program will also key on olfaction studies that include developing improved training and testing techniques as well as evaluating canine response to various explosives. A computer tomography system has collected data at an airport and will be integrated with a scanner or scan projection system to become the second-generation computer tomography explosives detection system. Research on nuclear resonance absorption and pulsed fast neutron system prototypes have been suspended for the near term. Fast neutron radiography is now being investigated and may be brought to the demonstration stage. Component research on these technologies will continue.

Weapons Detection

Methods to enhance current generation screening system performance are being investigated. Commercial weapons detection devices are being evaluated for deployment in airports, and

new standards are being developed to ensure that these screening systems continue to be effective. Alternate methods to detect nonmetallic weapons and liquid explosives are also being investigated along with passenger screening system development based on alternate technology.

Related Projects: 073–110 NAS Security, 075–110 Aircraft Hardening, and 076–110 Aviation Security Human Factors.

Products:

- Feasibility studies
- Prototype hardware
- Project evaluation reports
- Engineering procurement specifications
- Data to support rulemaking

1995 Accomplishments:

- Conduct operational prototype tests on the second generation computer tomography X–ray system, the portable ion mobility trace detection system for carry–on baggage, and the multi–view dual energy X–ray system.
- Conduct airport test of trace passenger portal.
- Complete laboratory integration of biosensor detector with new front–end collector.
- Develop canine readiness field test.
- Conduct combined technology tests with multiple X–ray systems for screening checked and/or carry-on baggage at a high-volume international airport.
- Conduct laboratory demonstration of a real-time millimeter wave nonmetallic weapons detection systems portal.
- Complete airport data collection on dielectic and nuclear magnetic resonance bottle screening systems.
- Develop portable ion mobility detector prototype.

Planned Activities:

<u>Explosives Detection</u>

First-generation detection systems will continue to be deployed while new detection systems development, including prototype trace portals, will continue with operational testing scheduled from 1996 through 1999.

Technology from the nuclear resonance absorption demonstration system will be transferred to industry in 1996, and development will continue on increasing capabilities, including drug detection. Nuclear research will focus on developing components, such as accelerators, targets, and detectors, through 1997. In 1996, testing will be performed on laboratory prototype systems for fast neutron spectroscopy/radiography and alternate multi-sensor systems designed for integration with compatible systems. Also, simulation and modeling will be conducted on nuclear and X–ray system configurations. In 1998, a baggage screening system simulation will be completed. Enhanced X–ray systems integration with trace and/or other technologies will be initiated and studied. Additional trace portal prototypes will be completed, and testing will begin at airports in the United States. Trace detector prototypes based on surface acoustic wave, frequency modulated infrared, and ion mobility spectroscopy technologies will be completed and undergo evaluation. From 1996–1997, operational testing will be conducted on the portable ion mobility detector prototype. A cargo container and mail X–ray scanning system laboratory prototype will be tested for explosives detection jointly with another agency in 1996.

In 1997, a laboratory prototype for the pulsed fast neutron system will be completed and a biotechnology trace detector prototype for area screening will be tested. An integrated trace, bulk, and new threat detection system for baggage inspection will be developed in 1998 to replace multiple detection systems in airports.

In 1998, an automatic high–volume passenger scanning portal will be developed to combine explosives and weapons detection systems.

New technologies will be identified and developed based on emerging threats, and those showing promise will be operationally tested in the laboratory and airports. Broad agency announcements, the grants program, or similar vehicles will continue to identify innovative approaches to this challenging problem and examine synergistic combinations of the sensor systems identified.

Weapons Detection

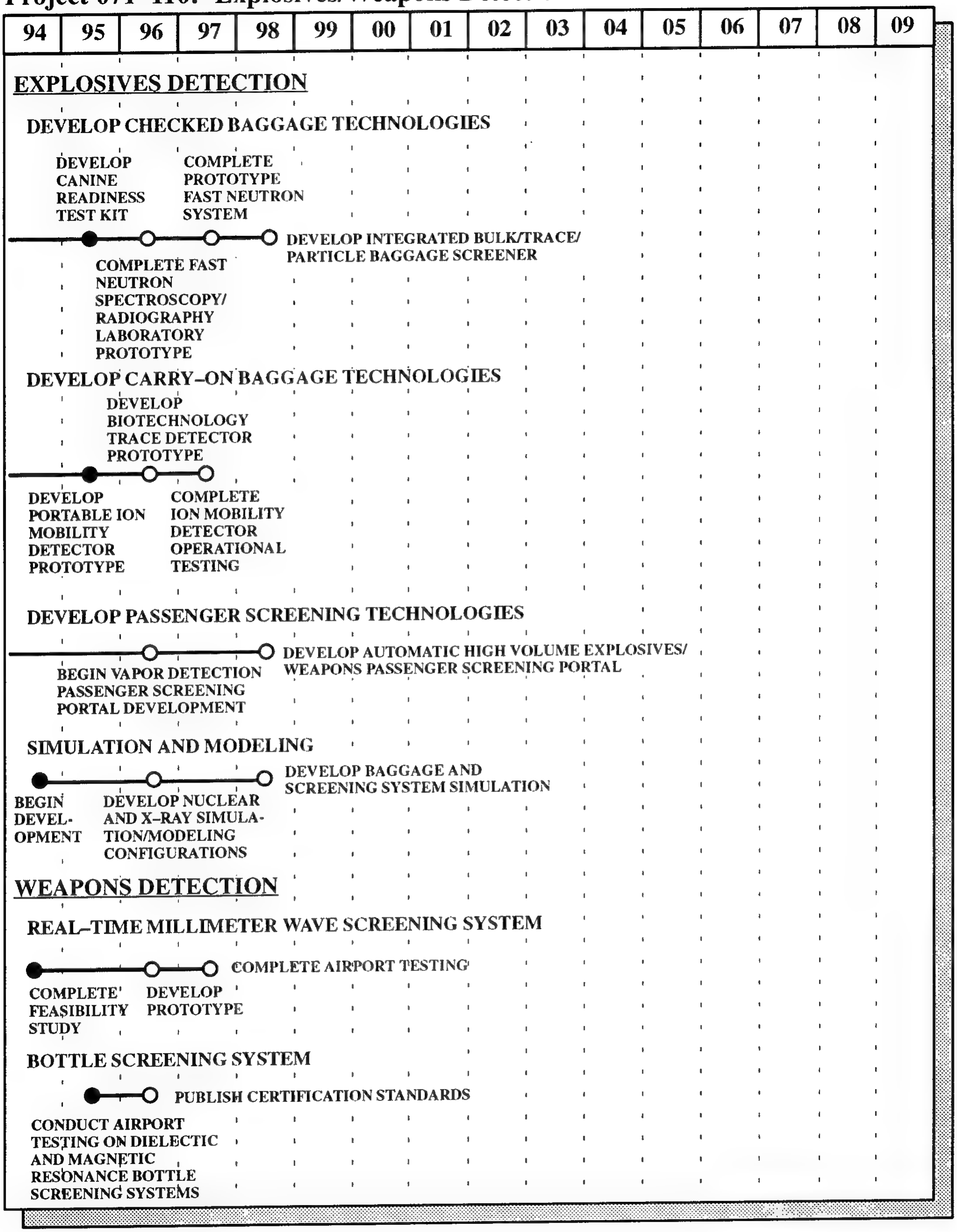
In 1996, lessons learned from the linear array technology will continue to be applied to the real–time millimeter wave system portal. Also in 1996, bottle screening certification standards will be published.

In 1997, a prototype real–time millimeter wave passenger scanner will be evaluated in the laboratory and tested at an airport.

In 1998, an automatic high–volume passenger scanning portal will be developed to combine explosives and weapons detection systems and then tested in the laboratory.

New technologies will be identified and developed based on emerging threats, and those showing promise will be operationally tested in the laboratory and airports. Broad agency announcements, the grants program, or similar vehicles will continue to identify innovative approaches to this challenging problem and examine synergistic combinations of the sensor systems identified.

Project 071–110: Explosives/Weapons Detection



073–110 NAS Security

Purpose: This project will determine the operational effectiveness, impact, and cost for enhanced airport security by using demonstration airports. Establishing demonstration airports will provide real–time testbeds for evaluating new security technology and procedures integrated into operational environments.

This project also will evaluate aviation security from a systems approach, determine if current systems integration is adequate, identify alternatives to counter evolving security threats, and identify additional requirements for research and development. A cost–effective and unobtrusive security system will become an integral part of normal civil aviation operations resulting from the various security research efforts that are currently underway.

Approach: Technology and procedures system integration and operational testing will determine whether new technologies and procedures are ready to be implemented in the operational aviation system, or whether further development is needed. New or enhanced training and operational procedures will be validated. Additionally, operational test results will be evaluated against threat/risk assessment and requirements definition to determine if the R,E&D products meet the objectives.

Protection for aviation targets has been prioritized based on current and predicted future terrorist threats to airports and operations. The prioritized targets have been correlated with existing FAA regulations and actual airport security plans. Enhanced system design and operational procedures will be developed to counter higher threat levels while maintaining economic viability, responsiveness, and normal passenger flow. New security designs and operational procedures will be implemented and evaluated in a testbed environment at Baltimore–Washington International Airport and other airports as needed. These testbeds will be used to test new technology in an operational environment for performance characteristics and operational procedures through cooperative research and development agreements with the aviation industry. Successful equipment will be considered for use throughout the system as appropriate.

This project will interpret and translate threat information into functional security system requirements using accepted analytical methods and tools. Modeling and applied research necessary to define security system parameters and constraints will be conducted. The model will contain information on current and future threats as well as technologies to counter each threat.

A long–range, strategic plan for developing and deploying aviation security system components will be developed to ensure that all components, attributes, and relationships needed to achieve a higher security level are identified and integrated into the system.

Alternative security system design approaches will be evaluated through system cost–effectiveness analyses and tradeoff studies. A feedback mechanism will be established for updating system requirements on a continuing basis as new threat or technology issues are identified through intelligence activities, research developments, and/or operational equipment and procedures testing.

Related Projects: 071–110 Explosives/Weapons Detection and 076–110 Aviation Security Human Factors.

Products:

- Airport vulnerability reports based on current and future threat definitions
- Integrated airport security conceptual design
- Upgraded airport security testbeds
- Project evaluation reports
- Operational guidelines
- Revised operations concepts and system requirements for an integrated enhanced aviation security system and responses to new threats
- Analytic models for threat/risk assessment
- Long–range, strategic plan for research, engineering, development, and deployment in an integrated aviation security system

1995 Accomplishments:

- Complete cost/benefit analysis on bar-code technology and profiling alternatives to secure checked baggage to support rulemaking.
- Host task force planning group to identify technologies for countering aviation industry threats.
- Develop analytical models for threat/risk assessment.
- Develop radio frequency technology for baggage and passenger tracking.

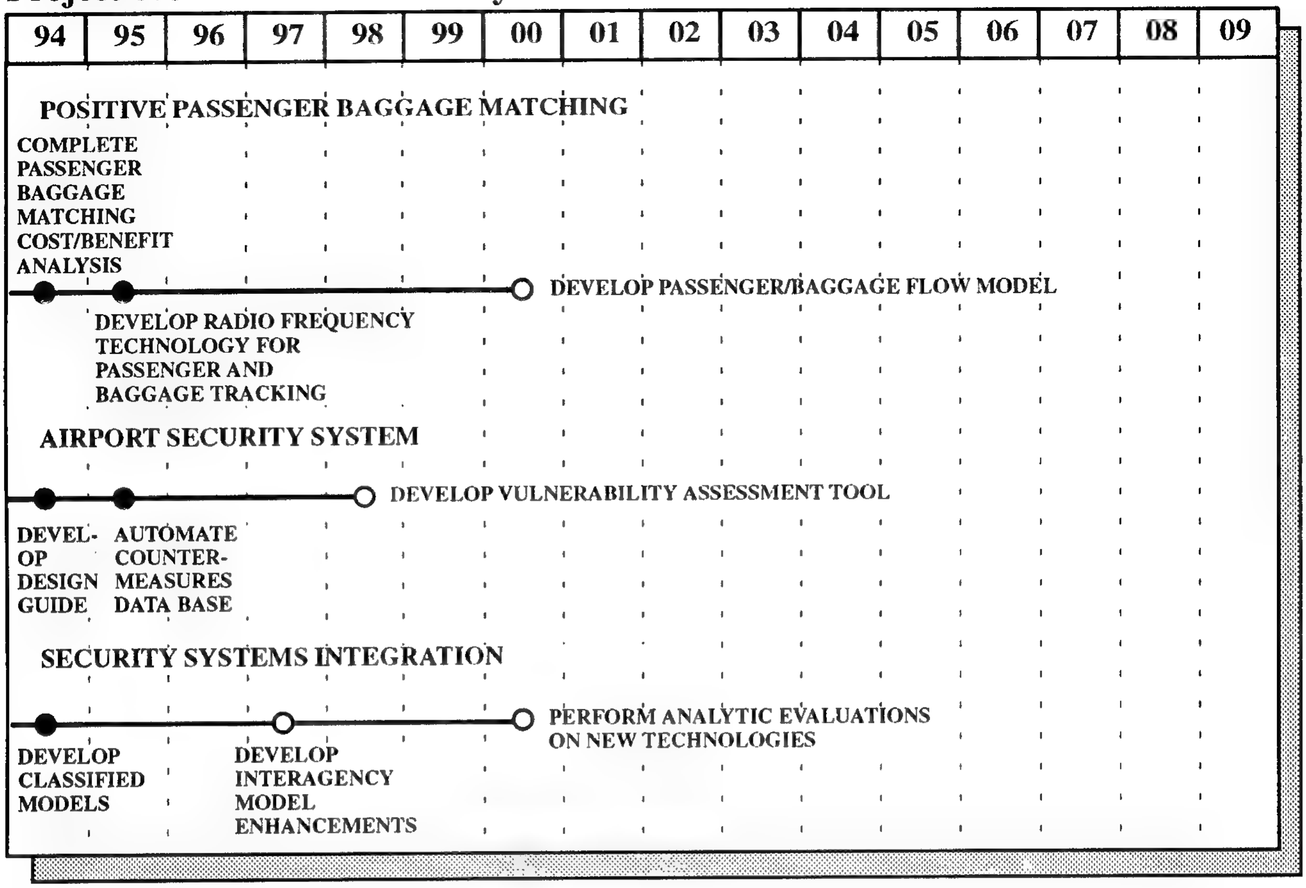
Planned Activities: An analysis process will be used to evaluate countermeasures and initiate requirements for research and development as new advanced threats emerge.

In 1996, threat/risk model work with other Government agencies will continue, and interfaces with other Government agency systems will be expanded. This work will continue through 1997. Sensor integration analytic evaluations will be performed as new technologies emerge.

Annually, reports on countermeasures for new advanced technical threats will be published. In 1998, an airport security vulnerability assessment tool will be completed.

In 2000, a passenger and baggage flow model will be developed to simulate the effects of security enhancements in the airport environment. Work will continue through 2000 for security integration, and analytic evaluations will be performed as new technologies emerge.

Project 073–110: NAS Security



075–110 Aircraft Hardening

Purpose: This project will identify methods to increase aircraft survivability by reducing damage effects caused by a small explosive detonation on a commercial airliner. The threat to commercial aircraft and passenger survival due to the in–flight detonation of a small explosive device is significant. Balancing current technology detection capability and aircraft hardening to withstand damage from a detonation in flight will be accelerated as required by the Aviation Security Improvement Act of 1990. In addition, the program is assessing possible terrorist threats to civil aviation caused by projected energy beams, mobile surface-to-air missiles, and specifically directed electromagnetic sources.

Approach: Blast loading parameters caused by various explosive types and quantities will be determined. Models will be developed to predict damage to an aircraft resulting from explosive detonations. Explosives testing will be conducted on aircraft and/or other test devices to verify models and assess damages using various scenarios. These tests will also be used to help determine aircraft vulnerability and validate blast mitigation/structural hardening techniques. Additionally, testing will be used to evaluate least–risk guidelines. Once failure mechanisms are identified, methods to protect an aircraft against catastrophic structural failure due to an in–flight explosion will be developed. To assess the civil

threat from projected energy beams, electromagnetic sources, and surface-to-air missiles, this project will use the extensive capabilities of the Department of Defense and other agencies.

Related Projects: 064–110 Flight Safety/Atmospheric Hazards, 065–110 Aging Aircraft, and 071–110 Explosives/Weapons Detection.

Products:

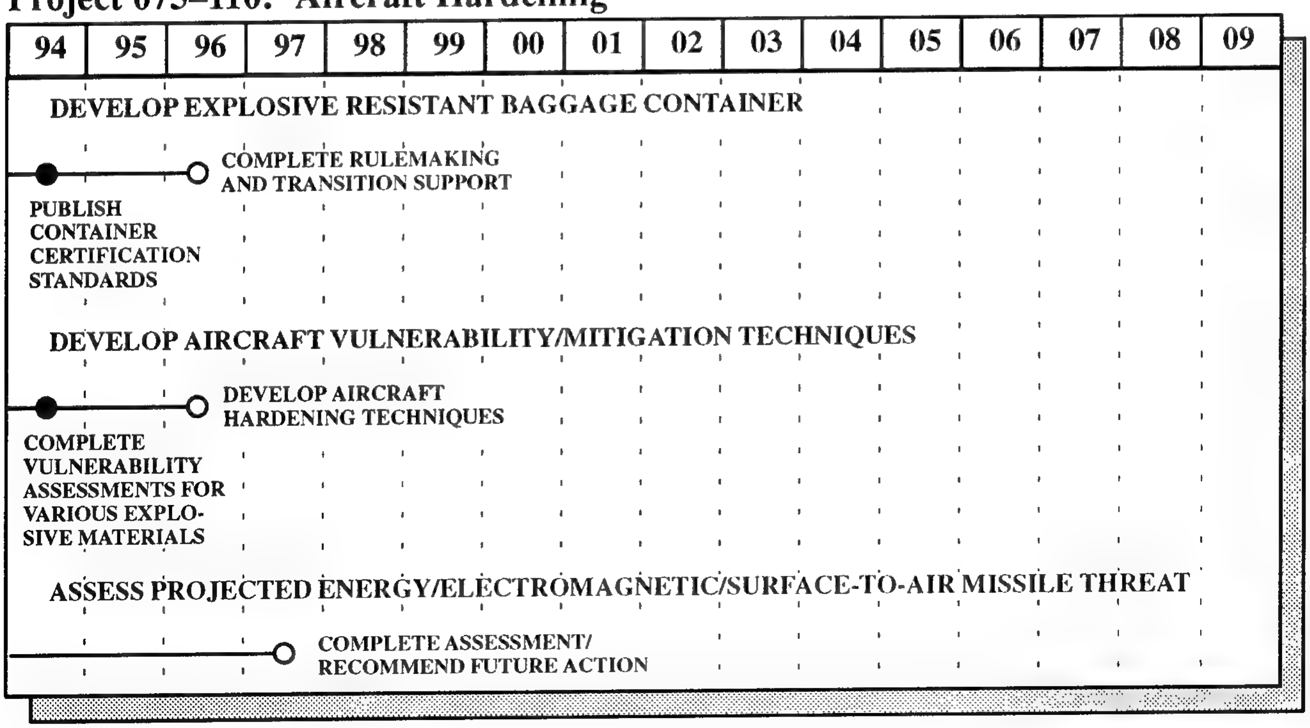
- Project evaluation reports
- Prototype hardware
- Guidelines for blast mitigation/aircraft hardening
- Engineering design specifications for aircraft and support equipment
- Threat assessments on different terrorist weapons

1995 Accomplishments:

- Provide data package to support hardened luggage container implementation.
- Establish memorandum of understanding with Department of Defense for cooperative research on alternative threats.

Planned Activities: In 1996, support for rulemaking and industry transition will be completed on explosive resistant baggage containers. Development of new explosive resistant hardening techniques will continue with recommendations for design specifications in 1996. Identifying methods and techniques to reduce vulnerability to other threats will continue through 1997. In 1997, an assessment will be completed and a recommendation will be made for a future course of action. These efforts will be coordinated with other R,E&D projects as appropriate.

Project 075–110: Aircraft Hardening



076–110 Aviation Security Human Factors

Purpose: This project carries out the mandate of the Aviation Security Improvement Act of 1990, Public Law 101–604. This law's intent is to "maximize human performance" within the aviation security system and "include research and development of both technological improvements and ways to enhance human performance."

Approach: This project addresses three primary areas: human systems integration (HSI) for new equipment designs, security system operational procedures development and testing, and security personnel selection, training, and performance monitoring. A key element is leveraging research and collaborating with other government agencies, the aviation industry, and academia.

This project will conduct research on X–ray screening, passenger profiling, and human systems integration. Screening research will focus on the Screener Proficiency Evaluation and Reporting System (SPEARS) technology for enhancing operator acquisition and sustainment training as well as performance monitoring. SPEARS will undergo operational test and evaluation to determine deficiencies and identify additional research requirements. Follow–on operational tests and evaluations will be conducted to confirm full functional capability.

This project will develop an automated domestic passenger profiling capability that analyzes a set of parameters determined by an interagency panel of security experts. This system will identify passengers requiring additional security screening and determine an implementation strategy for both active and passive profiling techniques. Also, this project will analyze and rate how acceptable increased security measures are to the flying public relative to costs and delays.

Human systems integration will address human characteristics required to interface with emerging technologies for security screening equipment. This project focuses on conducting assessments, developing procedures, and testing technologies for the various security areas within an airport environment. An important element of this research will be evaluating the complexity of multiple positions at a futuristic screening checkpoint for passengers and carry–on baggage. Also, the "challenge rule" will be evaluated to develop alternatives that increase its effectiveness. The "challenge rule" is the FAA regulation for airport and airline personnel to stop and question unauthorized individuals in the airport operations area.

Related Projects: 071–110 Explosives/Weapons Detection and 073–110 NAS Security.

Products:

- SPEARS operational testing and recommendations for implementation
- HSI analyses and reports on new explosives and weapons detection technology
- Automated domestic profiling system
- Recommended alternatives for enhancing "challenge rule" effectiveness
- Recommendations, guidelines, and regulatory packages for security training

1995 Accomplishments:

- Identify optimal human characteristics for performing baggage screening functions.
- Develop automated domestic profiling system.
- Develop active and passive profiling techniques and determined their domestic implementation effectiveness.

- Complete operational test and evaluation of SPEARS candidates.

Planned Activities:

Human Systems Integration

In 1996, a report on recommendations for carry–on baggage will be published, followed by reports on recommendations for passenger screening technology in 1997. In 1998, reports will be published on nuclear screening technology for cargo. As new threats emerge, technologies will be periodically developed and evaluated as countermeasures to those threats.

Security System Operational Procedures Development/Testing

In 1996, an international automated profiling system will be developed. Domestic and international profiling systems will be integrated in 1998.

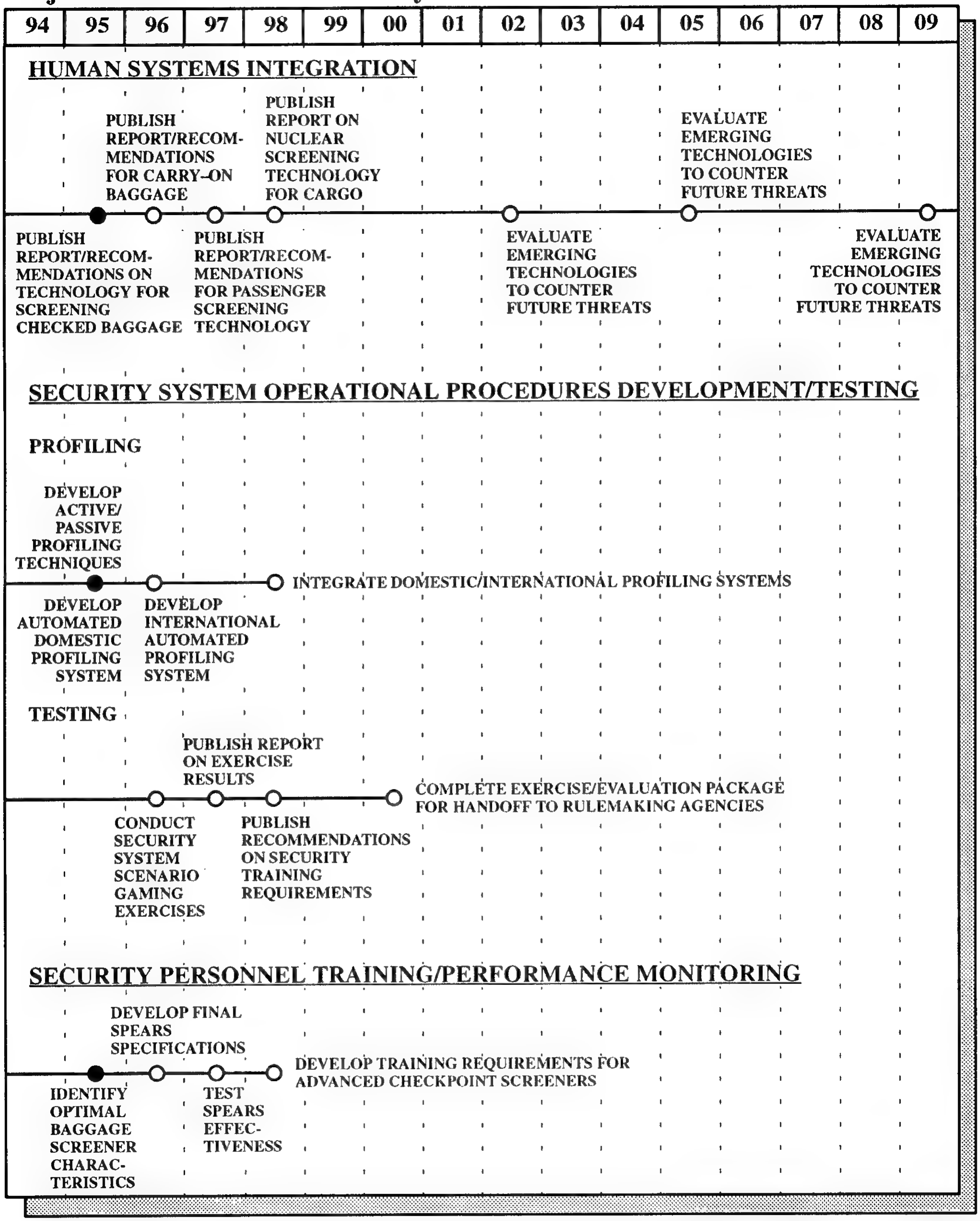
In 1996, security system scenario gaming exercises will be conducted and the exercise results will be published in 1997. In 1998, recommendations on security training requirements will be published. A complete exercise/evaluation package will be completed and ready for handoff to rulemaking agencies in 2000.

Security Personnel Training/Performance Monitoring

In 1996, final SPEARS specifications will be developed and SPEARS effectiveness will be tested on training and performance monitoring in 1997. Training requirements for advanced checkpoint screeners will be developed in 1998.

As new system and personnel security threats emerge, technologies will be periodically developed and evaluated to counter these threats.

Project 076–110: Aviation Security Human Factors



8.0 HUMAN FACTORS AND AVIATION MEDICINE

The human operator's role across all components of the National Airspace System (NAS) is critical to safe and efficient system operations. Advances in technology have increased the reliability of most system components, but the percentage of human error–related incidents and accidents has remained fairly constant. Historically, flight crew error has been cited as a contributing cause in over 60 percent of jet transport accidents, and the impact of human error is even higher when air traffic controllers, dispatchers, maintenance workers, and others are factored in.

Public, industry, and government concern for the human element in system performance resulted in Congress enacting the Aviation Safety Act of 1988 (Public Law 100–591), that called for the FAA to augment its research efforts in human factors and to coordinate programs with the National Aeronautics and Space Administration (NASA). The National Plan for Aviation Human Factors, published in 1990, represents an initial effort to strategically address human factors research requirements.

The research projects in this chapter directly support this Plan and the validated needs of internal and external users. These projects address major human factors priority areas related to: flight deck, air traffic control (ATC), flight deck/air traffic control system integration, airway facilities, aircraft maintenance, and aeromedical-aircraft cabin environments. These areas are:

Controls, Displays, and Advanced Technology

This thrust area encourages identifying and applying knowledge on the relative strengths and limitations of humans and computer-based technology to the design and certification of controls, displays, and advanced systems. A major focus is developing principles of human-centered automation that will enhance overall system performance.

Information Transfer and Management

The objective in this area is to determine the most effective means to transfer required information among all human elements in the NAS. Information transfer issues exist in all complex working environments where information flows between various combinations of people and machines.

Selection and Training

The focus of this thrust area is developing enhanced selection and training methods for aviation system personnel, supporting these methods with training devices and aids, and establishing criteria for assessing training needs.

Personal Safety and Survival

This thrust area addresses topics that are predominantly covered by the aviation medical community with emphasis on the aircraft cockpit and passenger compartments. There are three major sub-areas: crew and passenger survivability following an accident or incident, factors affecting crew and passenger health, and health and medical factors affecting human performance.

The goal is to improve understanding factors that significantly affect human performance in aviation. There are three major sub-areas: basic scientific knowledge to facilitate understanding baseline human performance, better insight into the environment's (external and internal) impact on human performance, and improved and standardized methods for measuring human performance.

The research projects in this chapter generally produce information as opposed to hardware. This information will continue to influence systems design, certification and regulation decisions, operations directives, and training procedures. The ultimate result is a safer and more efficient NAS operation.

8.1 Human Factors and Aviation Medicine Project Descriptions

081–110 Flight Deck Human Factors

Purpose: This project will improve human performance and reduce the adverse effects of errors in the cockpit through improved systems design, procedures, and training. An important element in this research is, when possible, applying existing knowledge of human capabilities and limitations to the flight deck environment. Where existing knowledge is inadequate, this project will develop a better understanding of human performance factors. Statistics show that approximately 65 percent of all fatal civil air transport accidents and a higher proportion of general aviation (GA) accidents list human error as a probable cause. Since flightcrew errors contribute to the majority of aircraft accidents, a continuing program directed toward improved flight deck human engineering, flightcrew performance standards, airman selection, and initial and recurrent training can pay for itself many times over by preventing a single accident. New technology developments and better flightcrew performance using existing technology will provide further benefits by increasing operational efficiency.

Approach: FAA and NASA share the responsibility for research in this project. Some of the current work is being accomplished under NASA's Aviation Safety/Automation Program, and some work is being accomplished as a collaborative effort. An important focus for the project is responding to relatively short–term requirements from sponsor organizations. A long–range goal is to develop the corporate human performance knowledge base that will scientifically support future rulemaking and safety programs.

Analytical, laboratory, simulation, and flight operational studies will be conducted in the following National Plan for Aviation Human Factors areas: automation, advanced technology, controls and displays, system safety monitoring, human performance, training and selection, and certification and validation standards. Information in data bases will be used to analyze the effects of selected human factor improvement methods, training, individual and operational stressors, and implementing increased automation. Research reports, conferences, recommendations, and direct assistance to the operational organizations will be used to support operational evaluations and develop advisory circulars, technical standard orders, and Federal Aviation Regulations (FAR) changes. Participation in technical committees such as the Society of Automotive Engineers will assist with developing industry practices and standards.

Related Projects: 022–140 General Aviation and Vertical Flight Technology Program, 082–110 Air Traffic Control Human Factors, 084–110 Flight Deck/ATC System Integration, and 086–110 Aeromedical Research.

Products:

- Guidelines for the human factors design, evaluation, and certification of advanced technology flight deck displays and control systems
- Research data base integrating information on pilot medical history, age, prior experience, airmanship history, and information on accidents and incidents
- Pilot and flightcrew behavioral coding techniques that can be used to assess flightcrew training program effectiveness

- Guidelines for improved training programs in crew resource management, aeronautical decisionmaking, instrument flight skills, and other critical pilot skills

- Guidelines for qualifying PC–based aviation training devices

- Model Advanced Qualification Program (AQP) for FAR Part 135 operators, ab initio training modules, and simulator standards for training/airman certification

- General aviation integrated navigation display cost/performance analyses

1995 Accomplishments:

- Publish guidelines for electronic chart designs.

- Complete initial automated performance measurement system prototype.

- Complete initial computer-aided debriefing station prototype for crew performance review following line-oriented flight training (LOFT) simulations.

- Install a reconfigurable advanced general aviation research simulator to support air crew performance research.

Planned Activities: In 1996, two university research grants will be completed on cockpit automation. These grants will identify safety issues and recommend appropriate automation levels and techniques. Research also will be conducted through 1998 to define flight data management system high frequency issues and analyze sensor architectures. This research will lead to a flight data sensor integration report in 1998 with recommendations for integrating aircraft sensor inputs with controller automation systems.

In 1996, development work will continue on an automated performance measurement system (APMS) for evaluating training program effectiveness. An advanced prototype will be completed in 1998, followed by operational evaluation and validation leading to advanced APMS specifications for airline use in 2000.

In 1996, a model AQP for FAR Part 135 operators will be developed. In 1997, a draft AC120–54 revision on AQP will be developed for the approval process. AQP research will continue on a refined model AQP for Part 121 and 135 operators with completion expected in 2000. In 1997, a software tool for line-oriented flight training scenario designs will be developed.

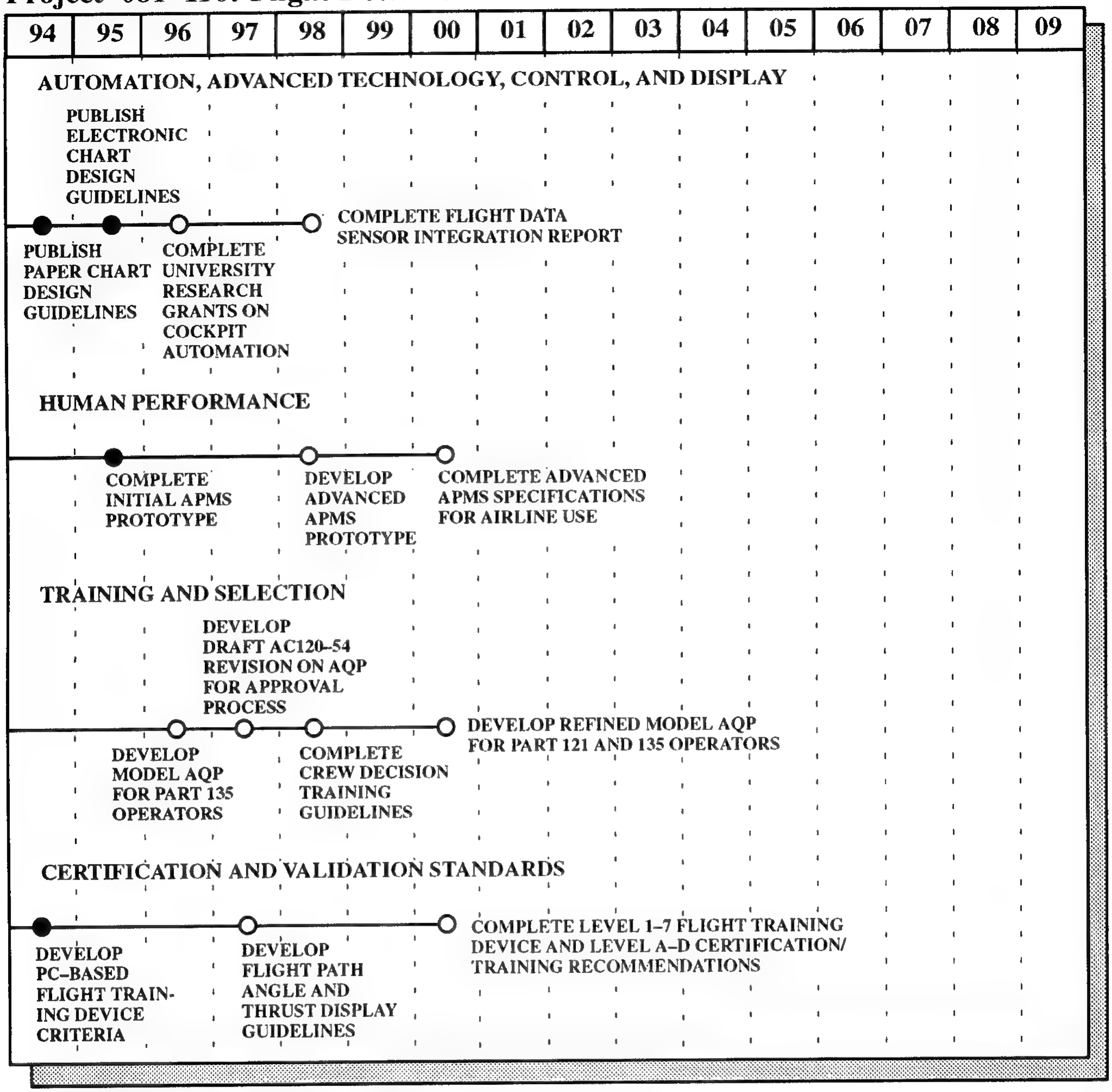
In 1996, work will continue on research to develop team training guidelines. This research studies the decisionmaking process among dispatchers, air traffic controllers, and pilots when an aircraft needs to divert from its original destination. Research will continue through 1998 when training guidelines will be issued.

In 1996, flight path angle and thrust indicators for heads up displays will continue to assist pilots in avoiding high-speed aborted take-offs.

From 1996 through 2000, systematic research efforts will quantify the performance transfer for level 1–7 flight training devices, and level A–D certification/training recommendations will be completed. This research is needed to establish the allowable credit for training and checking tasks when using a flight training device in place of actual aircraft flight training and testing.

In 1996, research will continue on producing objective data on air crew performance. This information will be used to produce certification guidelines and data to support regulation decisionmaking relative to aircraft design for the general aviation community.

Project 081–110: Flight Deck Human Factors



082–110 Air Traffic Control Human Factors

Purpose: Statistics show that human error is a probable cause in approximately 60 percent of aviation accidents. The FAA has recognized the role of human factors in operational errors, and the fact that human factors considerations are critical to effectively design, integrate, and evaluate equipment and procedures for use in air traffic operations. This project will improve human performance by providing guidelines to help increase controller effectiveness and reduce the

likelihood of system–induced human operational errors.

Approach: The Air Traffic Control Human Factors project operates in consonance with other FAA strategic and program plans as well as the National Plan for Aviation Human Factors. This project is designed to increase air traffic control system safety and efficiency by: applying human factors to designing and integrating new air traffic control equipment and procedures; exploring human perceptual capabilities and limitations as they relate to ATC systems; studying operational error causes and providing recommendations to reduce their frequency; developing standards and guidelines for applying human factors engineering to ATC system acquisition and evaluation; developing performance measurement methods and criteria for ATC system applications; determining automation's effect on controller work activities, performance, and productivity; and studying new technologies to improve controller selection and training.

An important by–product of all efforts in this project is developing reference information on human factors that can be applied in formulating future operational requirements. It is imperative that human factors be considered at a program's inception and integrated throughout its developmental lifecycle. Conducting human factors research early in the development process will help identify design deficiencies when they are easier to correct and prevent fielding systems that have the potential to induce operator error.

Analyses on organizational and environmental factors affecting controller performance will provide data leading to innovative methods for improving safety and productivity. Situational factors and workforce characteristics affecting the controllers' job performance will provide performance–based feedback tools that management can use to assess the results of change in the environment.

Detailed job task analyses, training evaluations, and performance assessments will be conducted across the ATC system operations spectrum. This research will enable the FAA to effectively accommodate evolutionary changes in the ATC system. The result will be ATC personnel systems closely integrated with, and reflecting the operational requirements of, future highly automated ATC systems.

A related effort is developing and validating performance measures sensitive to controller workload and decisionmaking. This effort will enable the FAA to determine objectively whether given ATC systems and equipment are beneficial to controller performance.

Assessing automation's impact on controllers will provide insights into the complex interaction between man and machine. The result will be guidelines to help the FAA ensure that automated systems fully support air traffic controllers, minimize human error probability, and maximize both safety and efficiency.

Related Projects: 081–110 Flight Deck Human Factors, 084–110 Flight Deck/ATC Integration, and 086–110 Aeromedical Research.

Products:

- Human factors requirements guidelines for designing, integrating, and evaluating ATC systems for human operators

- Analysis tools and standards for assessing/predicting controller work activity and performance

- Guidelines and models for optimally allocating operational functions and tasks to controllers and their equipment

- Real–time simulations, rapid prototyping, computational models, and reference data that support FAA specifications, acquisitions, and tests for improving air traffic control equipment and procedures

- Capability to reconstruct en route operational errors and incidents

- Tools and reference information for improved performance–based controller selection, training, certification, and retention

1995 Accomplishments:

- Develop guidelines to enhance tower cab training programs.

- Develop initial controller performance measurement tools.

- Develop situational awareness information requirements checklist for use in analyzing operational errors.

- Publish technical report on using oculometry display scanning as an index of controller situational awareness.

- Complete evaluations of: tower cab simulation training devices, 3–dimensional radar display techniques, and countermeasures for shift-induced fatigue.

Planned Activities:

Air Traffic Controller Selection and Training

In 1996, research on tower simulation technology will continue, leading to functional specification development for tower simulators. Training needs will be analyzed through 1998, and prototype functional specifications will be completed in 1999. A prototype simulator based on the specifications will be developed in 2000 for evaluation and validation by 2001. Final tower simulator functional specifications will be completed in 2002. A concurrent effort will focus on methods specifically designed to enhance tower cab controller team training in managing complex decisionmaking situations. This effort will provide initial guidelines in 1996 and will be completed in 1997.

Long–range research will continue to determine the most effective way to incorporate new technologies for controller selection, training, and certification. From 1996–1998, research will be conducted on enhanced controller selection and screening methodologies. These methodologies will undergo a testing and validation period through 2001, followed by a decision point on implementation. This effort will also evaluate innovative technologies such as interactive CD–ROM, voice recognition, and holographic displays from 1997–1999. In 2000, development will then proceed on those technologies that have the most potential for training/screening applications.

Air Traffic Controller Performance

In 1996, efforts will continue to refine and validate controller performance measures. Also in 1996, the initial performance metrics will be developed and published in a handbook. These measurement tools will be used to establish a performance baseline for controllers by 1998. From 1998–2000, the performance metrics will be evaluated and refined, then published in an updated handbook in 2000. The objective performance metrics will be used to develop equipment design specifications, procedural changes, and training programs from 2000–2005.

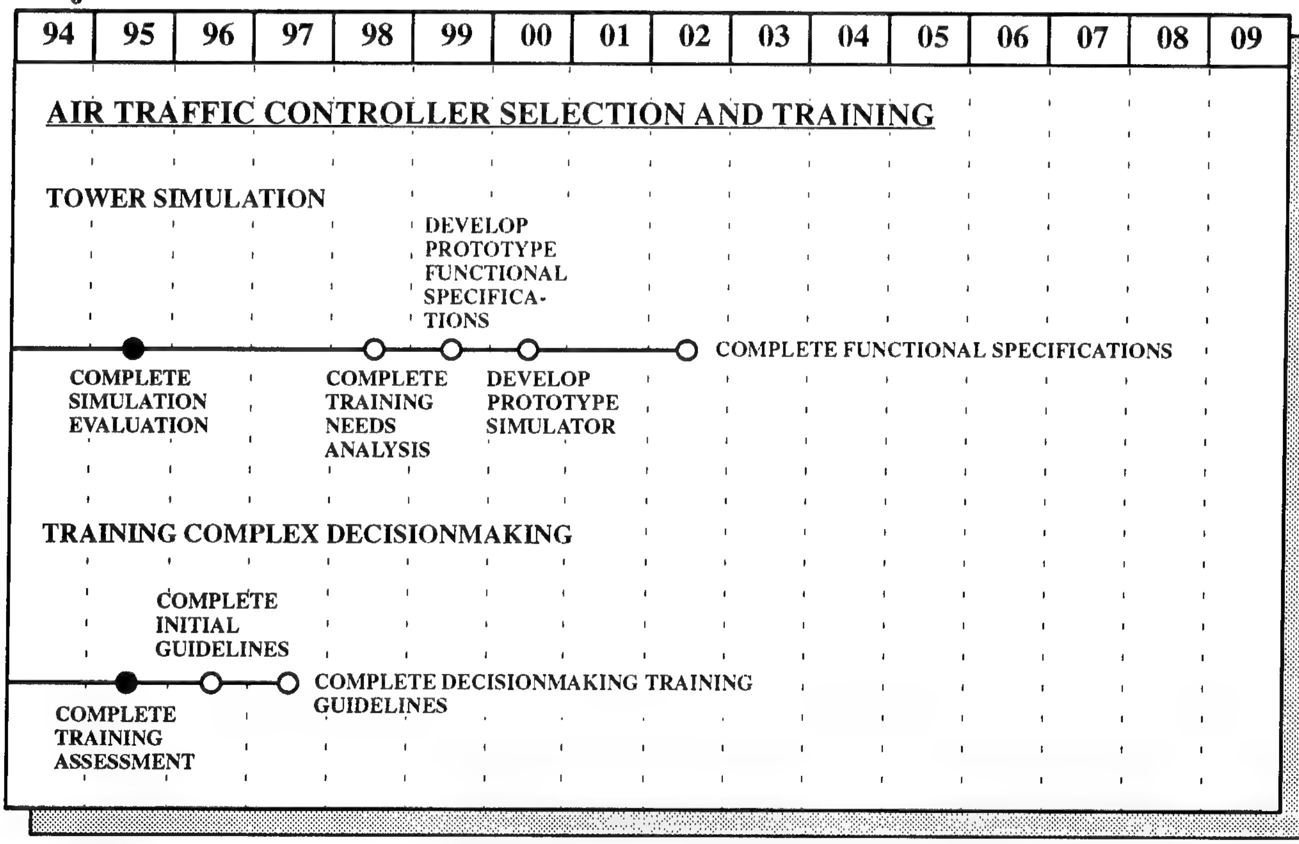
From 1996–1999, research will continue on evaluating the effectiveness of countermeasures for shift-induced fatigue and determining their relevance in field settings. This research will focus on evaluating ATC shift schedules and developing countermeasures for the effects of rotating shifts.

In 1996, developing new applications for the situational assessment through operational replay of incidents (SATORI) tool will continue. From 1996–1997, SATORI will be used to develop measures of terminal radar approach control personnel taskload and performance. These measures will be published in 1997. From 1997–1999, research will be conducted to enhance SATORI software applications.

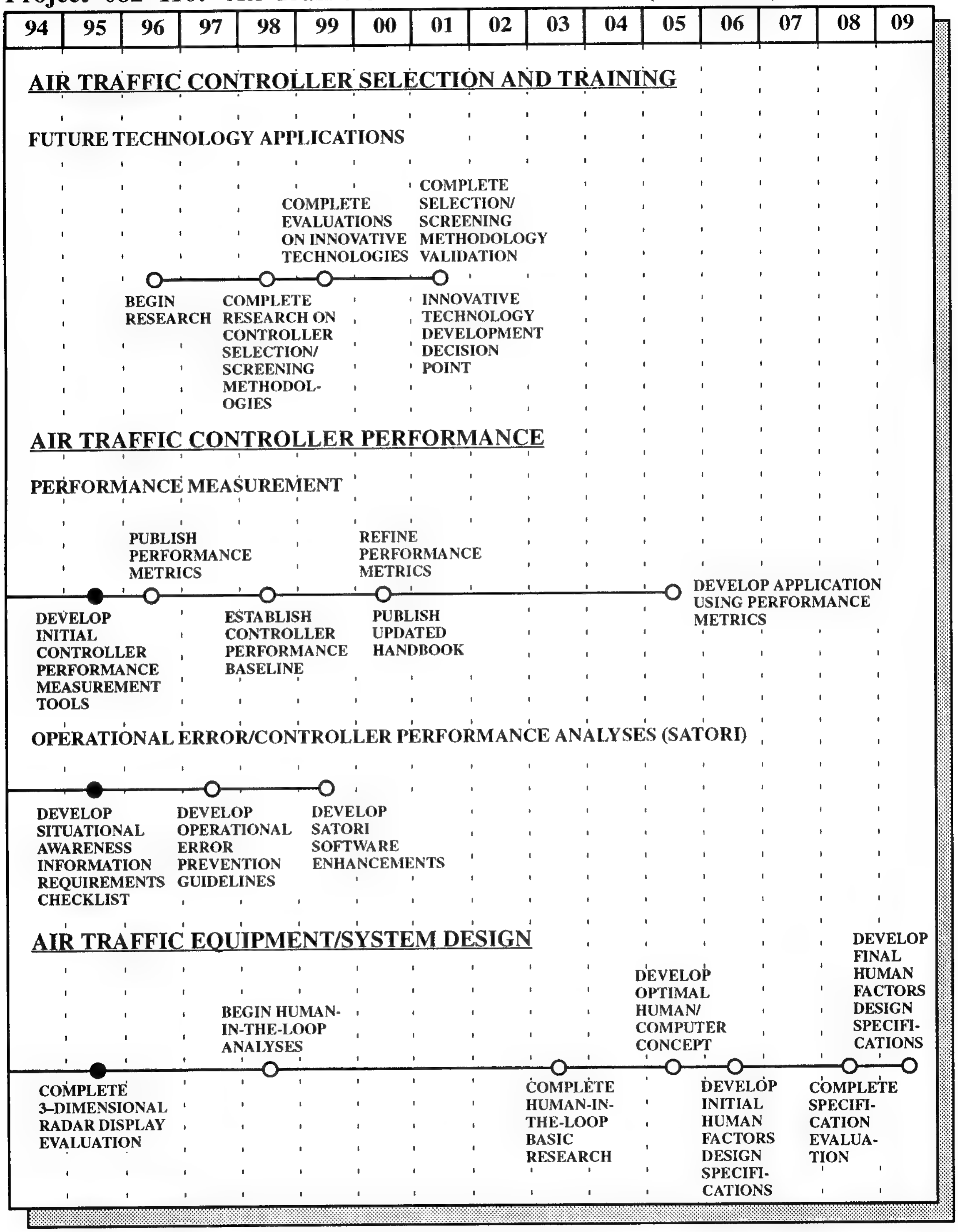
Air Traffic Control Equipment/System Design

In 1998, research will be initiated to determine the most appropriate role for human operators in the highly automated ATC system of the future. From 1998–2003, human–in–the–loop analyses will be conducted for an ATC–specific environment. These research findings will be used with next–generation ATC automation system projections to develop an optimal human/computer concept by 2005. The premise for this concept will be to address automated equipment and human operators as integral parts of a whole system. Initial specifications based on the human/computer concept will be developed in 2006 for evaluation from 2006–2008. Final human factors design specifications for next–generation ATC automation systems will be developed by 2009.

Project 082–110: Air Traffic Control Human Factors



Project 082–110: Air Traffic Control Human Factors (continued)



083–110 Airway Facilities Human Factors

Purpose: The Airway Facilities (AF) organization has developed a strategic plan to manage change that is occurring as AF grows into a more system management oriented organization. This plan addresses the vision of the Airway Facilities future organization and provides the outline for transitioning to this new operational concept. The AF Human Factors project provides the means by which user–system interfaces inherent in the strategic plan can be validated and alternatives for implementation can be addressed.

The purpose of this project is to reduce the impact of change on the organization and to provide the necessary information for implementing the strategic plan. By conducting research in future workforce selection and training; organizational effectiveness; user–centered maintenance automation; and human performance, the AF Human Factors project will provide the input necessary to make informed decisions regarding the best methods to implement the strategic plan and achieve AF goals.

Approach: Task analyses will be conducted to provide the necessary data for developing knowledge, skills, abilities, position descriptions, and training criteria for current and future positions in automated systems. These analyses will also be used to develop computer/human interfaces (CHI) for new systems and determine where artificial intelligence and expert systems can best be incorporated into the maintenance environment. Simulations will be developed for different work environments to determine the impact of policy and/or procedural changes on workload and staffing. The evolving AF system specialist's role and workload in an automated system will be analyzed and appropriate interfaces developed to take advantage of advanced technology.

Related Projects: 026–110 Airway Facilities Future Technologies, 082–110 Air Traffic Control Human Factors, and 085–110 Aircraft Maintenance Human Factors. Capital Investment Plan projects: 26–01 Remote Maintenance Monitoring System (RMMS).

Products:

- Higher order Airway Facilities task analysis for future and expert systems applications and training/selection requirements for AF personnel
- Criteria for effectively using intelligent systems in AF maintenance
- Human factors design interface specifications for future systems, including workstations, Operations Control Centers (OCC's), and job aids
- AF personnel knowledge, skills, and abilities considerations suitable for inclusion in the specifications for new Airway Facilities procurements
- Organizational effectiveness analyses to baseline current maintenance functions, policies, and procedures leading to future system performance improvements

1995 Accomplishments:

- Complete current AF organizational effectiveness analysis.
- Develop prototype OCC situation awareness displays.
- Publish human factors design standard.

Planned Activities:

Human Systems Optimization

In 1996, development work and evaluation will begin on self-managed team prototypes with completion expected in 1999. In 1999, self-managed team implementation will begin along with a performance evaluation cycle that will be completed in 2003. Depending upon the performance evaluation results, self-managed team standards will be revised in 2005.

Advanced User Systems Interface

In 1996, advanced display symbol standards will be completed. In 1997, scenarios for integrated system–level testing will be developed, and testing/evaluation will be initiated for linked personal computers and other expert systems. From 1998–2000, these scenarios will be used in an integrated testbed for simulating a hierarchy of subsystems such as automated diagnostics, predictive weather systems, decision support systems, and workforce composition. By 1999, computer/human interface requirements will be completed for developing OCC/workstation performance specifications in 2000.

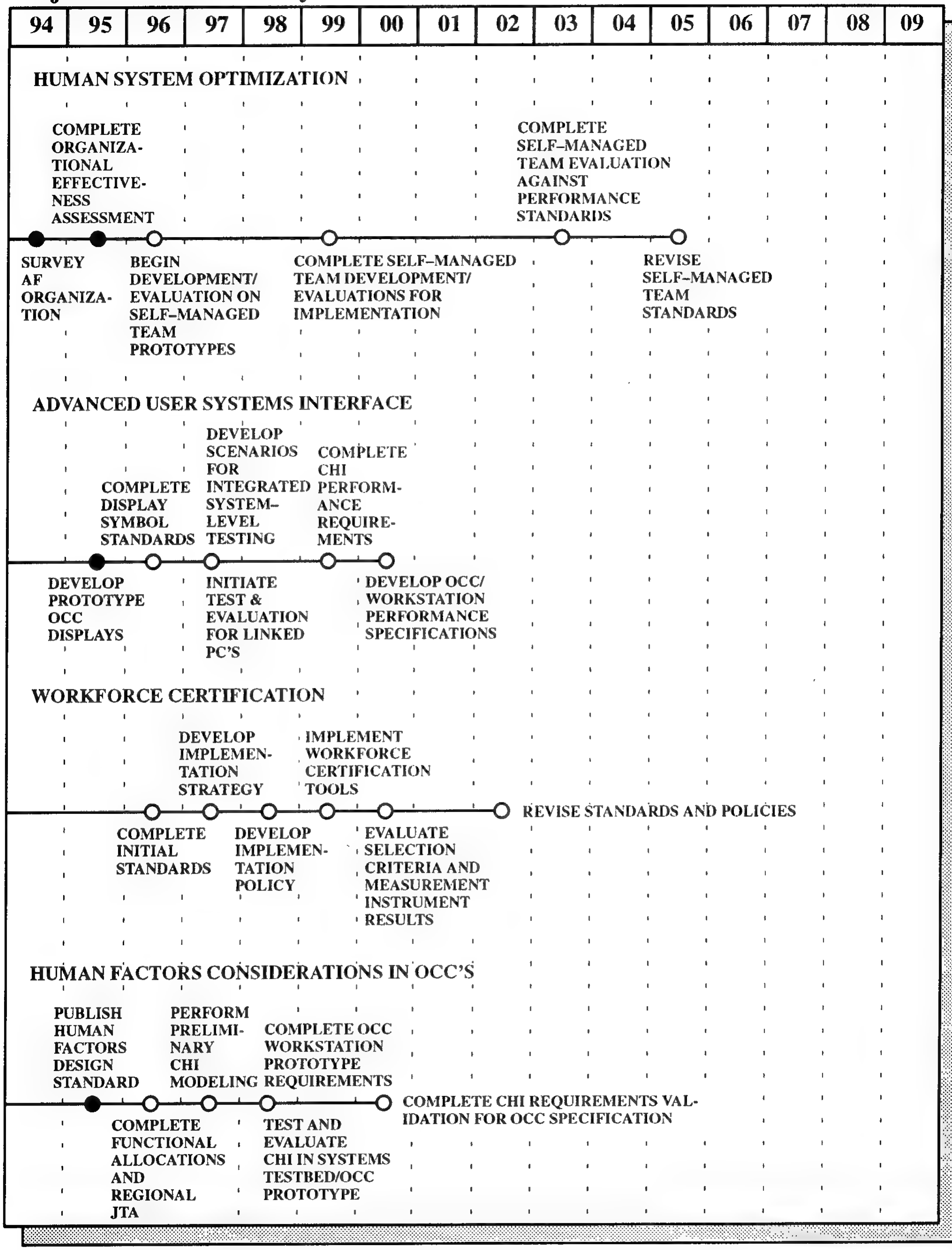
Workforce Certification

In 1996, initial standards will be completed for recruitment, pre–assessment, and entry–level AF technical training. In 1997, an implementation strategy will be developed to introduce the initial standard into AF operations followed by an implementation policy in 1998. In 1999, the new workforce certification processes and measurement instruments will be fielded. In 2000, the initial selection criteria for recruitment and pre–assessment will be evaluated, as well as workforce certification processes and measurement instruments. If needed, the standards, policies, processes, and measurement instruments will be revised in 2002.

Human Factors Considerations in OCC's

In 1996, functional allocations and residual job task analyses (JTA's) will be completed. The residual JTA's are for future OCC positions not covered under previous JTA work. In 1997, the JTA data will be incorporated into preliminary computer/human interface models to examine their implications for information display and processing, job satisfaction under automated conditions, workload, and error mitigation. These models will be used to complete OCC workstation prototype requirements in 1998. These requirements will support OCC workstation prototype development in 1998. Also in 1998, the computer/human interface to the OCC workstation will be tested and evaluated in the AF systems testbed/OCC prototype developed by the Airway Facilities Future Technologies project. In 2000, the computer/human interface requirements will be validated and incorporated into the OCC specifications.

Project 083–110: Airway Facilities Human Factors



084–110 Flight Deck/ATC System Integration

Purpose: This project will ensure new-generation aircraft compatibility with the evolving automated NAS and decrease the frequency of flight deck/ATC communications errors through a total system approach. Flight deck/ATC Integration raises unique considerations that are distinct from either ATC or flight deck issues and will be greatly affected by the technological improvements that are expected to occur simultaneously within both areas. Advanced computer aiding will facilitate controllers handling increased traffic but will also influence flightcrew performance and situational awareness. Data link, and ultimately satellite–based air traffic systems, have the potential to enhance system capacity, but will also influence controller and pilot workload in ways that are not currently understood. NAS safety and efficiency will be enhanced through system–wide analyses that integrate current and emerging airborne and ground subsystems.

Approach: This project's objective is to enhance flight deck/ATC information transfer and management; decrease frequencies and consequences of flight deck ATC errors; determine appropriate authority allocation between flight deck and ATC; and develop the required methods, tools, and guidelines for integrating NAS components into the flight deck ATC environment.

The information transfer area will focus on identifying and resolving issues associated with transferring and managing information exchanged between the flight deck and ATC system. The areas to be studied include ATC clearances, traffic, weather, facility and equipment status, and related information. Both air–to–ground and ground–to–air information and data exchanges are of equal importance. The goal is to reduce information transfer errors and minimize their impact when they occur.

Verbal communications in ATC operations have been identified as causal factors in over 70 percent of operational errors and pilot deviations. Consequently, one of this project's major research areas focuses on developing means to decrease the frequencies/consequences resulting from pilot and controller communication errors. Efforts will focus on three areas: a pilot/controller communications analysis examining ATC voice tapes; analyses of aviation safety reporting system reports; and a series of laboratory experiments to assess the effectiveness of recommended changes in procedures and/or phraseology.

As intelligent automation applications increase on the ground as well as the flight deck, allocating authority between pilots and controllers becomes less well defined. This project will develop a decision support system (DSS) to predict different authority allocations for various en route services. The DSS will help the FAA make decisions on future pilot/controller selection, training, and operational authority allocation.

In cooperation with NASA, this program has jointly acquired and will operate a Boeing 747–400 research simulator with state-of-the-art avionics representing aircraft that will be predominant in airline fleets during the next decade. The simulator will be capable of stand–alone use, or can link via satellite to FAA ATC simulation facilities. Simulation studies involving this advanced technology cockpit will eventually be integrated into the National Simulation Capability. To operate a high-fidelity research simulator requires continued infrastructure investment, which this project will provide.

Related Projects: 025–110 National Simulation Capability (NSC), 031–110 Aeronautical Data Link Communications and Applications, 081–110 Flight Deck Human Factors, 082–110 Air Traffic Control Human Factors, and 086–110 Aeromedical Research.

Products:

- Human factors guidelines needed to set policies for data link architectures and procedures
- Human factors guidelines for developing, testing, and certifying interface designs of various computer/human interface applications
- Operational and training recommendations to reduce pilot/controller verbal and digital communication errors
- Revised selection and training criteria to certification and regulatory personnel to ensure available skills are matched with the changing demands on pilots and controllers
- Capability to assess human performance in a highly integrated future automation environment
- Human factors guidelines that set protocols and policies for airport surface traffic automation architectures and procedures

1995 Accomplishments:

- Conduct first system integration experiments using the Boeing 747–400 simulator to support the National Plan for Aviation Human Factors and the National Simulation Capability Operating Plan.
- Provide recommendations to reduce pilot/controller communication procedures and phraseology errors.
- Define potential allocation strategies for distributing automation control decisions between flight deck and ATC.

Planned Activities: As new data link applications emerge, standards and certification guidelines, protocols, and procedures will continually be developed and/or revised. In 1996, this project will identify conditions that have the potential to produce data link communication errors. Research will then be conducted on developing procedural and design solutions that reduce the likelihood or minimize the effect of those errors. Through 1998, standards will be recommended for display content, format, menu design, message displacement, data link function control, and message alerting. In 1997, design and/or procedural solutions will be recommended to compensate for losing party line information if discrete data link replaces open frequency broadcasts. These solutions will ensure that flightcrews maintain situational awareness.

In 1996, recommended changes in pilot/controller communication procedures and phraseology will be provided to regulatory personnel for possible implementation.

In 1996, research will continue on developing compensation techniques to ensure pilot/controller situational awareness when discrete digital communications are implemented. As automation and data link systems come online, techniques must be developed that provide the proper information at the appropriate time to keep human beings in the decisionmaking loop. The current line of research is expected to be completed in 1997.

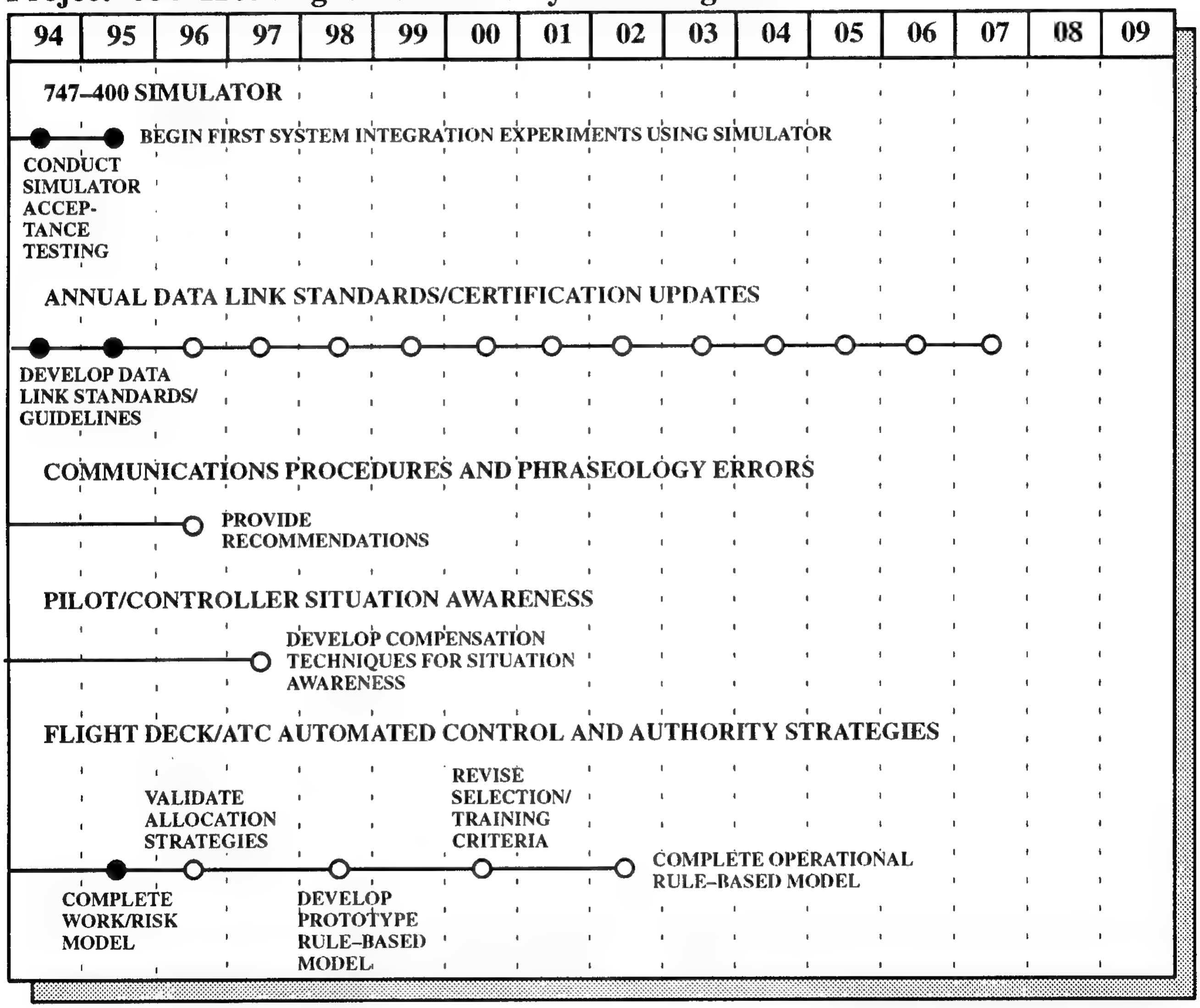
In 1996, research will continue on authority/responsibility allocations between pilots and controllers. One key research element will be developing a model that aids in predicting shifting authority allocations between the flight deck and ATC due to intelligent automation. In 1996, allocation strategies will be validated for distributing control decisions among the pilot, the controller, the airline dispatcher, and the NAS automation system. Validating these strategies will lead to developing a prototype rule-based model in 1998 for use in various system design applications. This prototype will be transferred

to the FAA Technical Center in 1999 for further developmental testing, with an operational model expected by 2002.

Revised selection and training criteria will be provided by 2000 to certification and regulatory personnel. This criteria will ensure that available skills are matched with the changing automation demands on pilots and controllers.

It is important to recognize that system integration research will never produce a definitive product that will close out this research domain; rather, it is a continual process that must be applied to every new generation of technologies as they emerge.

Project 084–110: Flight Deck/ATC System Integration



085–110 Aircraft Maintenance Human Factors

Purpose: This project will develop and validate training methods to improve aircraft maintenance and inspection personnel performance; develop regulatory support materials to revise Federal Aviation Regulation Parts 65 and 147; develop information on advanced technology, techniques, and job performance aids for industry aircraft maintenance personnel and FAA Aviation Safety Inspectors (ASI); and develop information on how workplace environment and organization affect technician performance. A better understanding of these variables will lead to enhanced training methods, improved equipment human engineering, and improved FAA regulations/oversight. Accidents and incidents in air carrier operations attributable to maintenance and inspection human factors will be reduced as a result of this effort.

Research conducted in this area will ensure that future maintenance technicians will be optimally prepared for their roles. This research will develop guidelines and advisory materials for air carrier maintenance organizations concerning work environment factors that influence maintenance personnel performance. Also, information will be developed concerning the effects of advanced technology systems on FAA ASI performance.

Approach: This project addresses the following areas of the National Plan for Aviation Human Factors: personnel and training systems, advanced technology systems, and environmental and organizational systems. It is important to remember that as new technology continues to enter the system, human factors research must be performed to ensure that the human/machine interface is optimized. This research will continue into new areas as technology evolves.

This project will conduct research on visual and nondestructive inspection (NDI) techniques. Laboratory and field research studies will be conducted to determine factors that influence air carrier inspection specialists' performance. Advisory guidance material based on this information will be supplied to air carrier maintenance managers for training, planning, and work assignment purposes.

A major element in this project is researching information needs for FAA field inspectors. The intent is to examine existing processes and develop improved methods for ASI's to access needed information and provide input to national data bases. ASI's have frequent need to access information such as advisory circulars, airworthiness directives, and regulations. Inspectors also need to provide the results of their inspections so that information is quickly accessible to data base users. Various computer–based technologies will be explored to determine their utility in optimizing inspector performance.

Work environment research has developed knowledge of visual, auditory, thermal, and biomechanical requirements or limitations concerning skilled psychomotor activity in general. Subsequent work will seek to apply this knowledge to specific aircraft maintenance cases. Organizational/managerial research will examine the influence of management practices, expectations, and norms as well as personnel practices, team operations, and organizational structure on maintenance performance.

Related Projects: 065–110 Aging Aircraft.

Products:

- Job task and training analyses
- Intelligent tutoring systems
- Supporting data for FAR Parts 65 and 147 revisions

- Human factors guidelines for industry/Government communication, data exchange, and support infrastructure

- Advanced documentation technology to provide rapid access to technical information

1995 Accomplishments:

- Develop concept guidelines on maintenance crew resource management.

- Complete aviation safety inspector job aid tool.

- Develop electronic version of human factors issues guidebook.

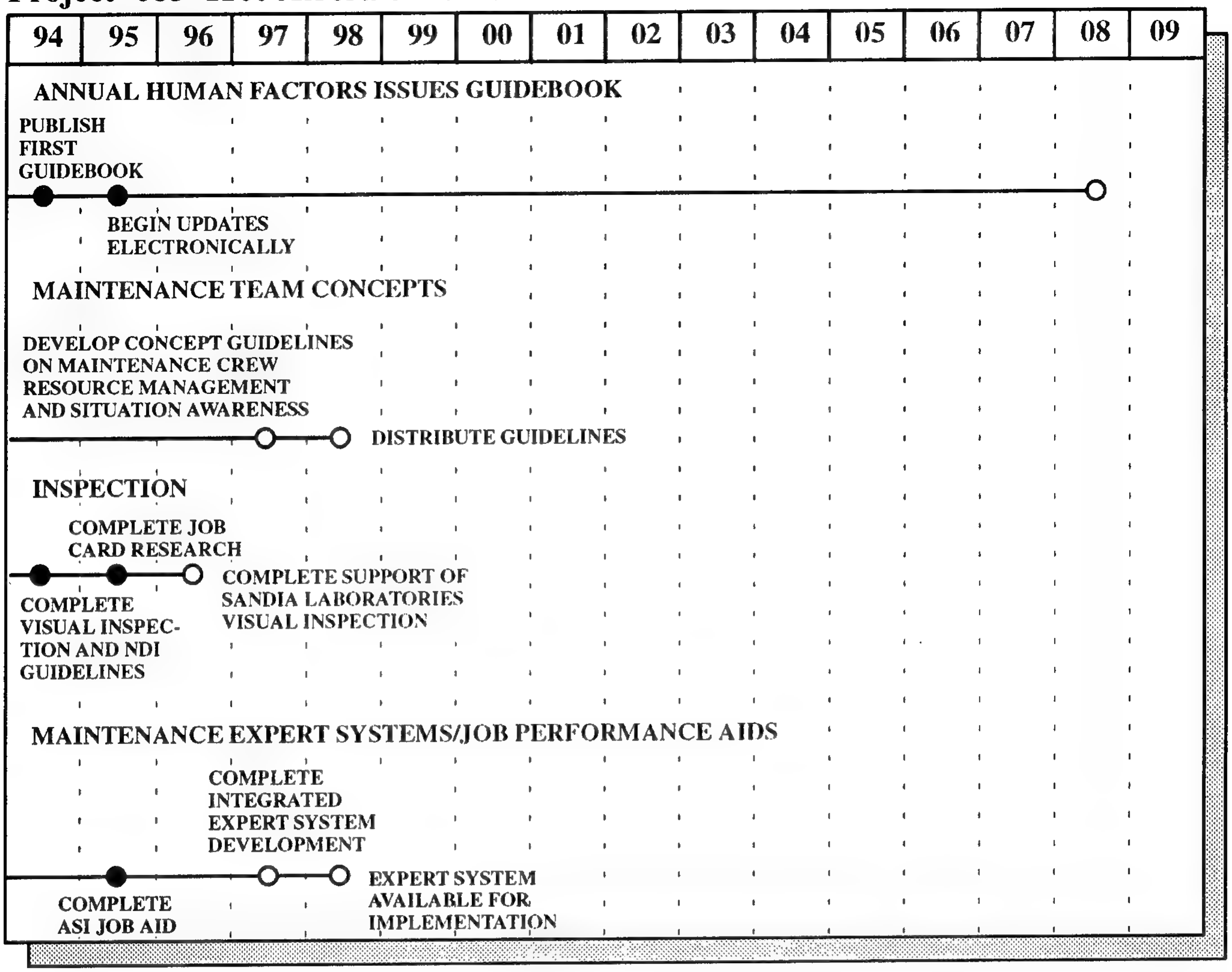
Planned Activities: In 1996, updates will be published to the human factors issues guidebook. These updates will be published annually in an electronic format.

In 1996–1997, guidelines will be developed on maintenance crew resource management and situational awareness. Results from these guidelines will be made available to regulatory organizations and industry by 1998.

In 1996, previously completed techniques on visual inspection and NDI will undergo testing at Sandia Laboratories to support the aging aircraft program.

In 1996–1997, an expert system will be developed for integrated training/job aiding/information retrieval. Voice recognition, a key human/system component, will be evaluated. In 1998, the complete system will be available for implementation.

Project 085–110: Aircraft Maintenance Human Factors



086–110 Aeromedical Research

Purpose: This project will assess types of injury and death patterns in civilian flight environments, recommend and develop protective equipment or procedures, and provide guidance to FAA regulatory and medical certification staff. The component tasks of this research will identify human physiological and bioengineering failure modes in both uneventful flight and during civil aircraft incidents/accidents, while simultaneously assessing counteracting measures. The research will also identify pilot and passenger medical conditions that are incompatible with civilian flight demands. This detailed information will be used to determine if existing equipment and procedures optimally protect the human occupant; to make technical recommendations contributing to improved performance standards; and to support bioengineering, biochemistry, and biomedical aspects of certification actions and rulemaking. Prioritizing subtasks is directly responsive to the Aircraft Certification Service and the Federal Air Surgeon, and also to unique injury and death characteristics in contemporary accidents. This prioritization allows the FAA and the

National Transportation Safety Board to effect expeditious corrections of unsafe and dangerous conditions.

Approach: Tasks in this research area are derived from requirements generated within the FAA by the Aircraft Certification Service, the Flight Standards Service, the Northwest Mountain Region Transport Airplane Directorate, the Southwest Region Rotorcraft Directorate, the Central Region Small Airplane Directorate, and the Offices of Aviation Medicine, Aviation Safety, and Accident Investigation. Organizations outside the FAA generating requirements through FAA channels include the National Transportation Safety Board, the military services, and the Society of Aerospace Engineers. All project activities are coordinated with Government agencies and industrial representatives having related technical interests. The FAA research process ensures project coordination among the FAA performing organizations, such as the Civil Aeromedical Institute and the Technical Center.

This project broadly encompasses laboratory and field studies on the performance of the cabin crew, medically certified airmen, and aircraft passengers. Furthermore, equipment and procedures approved by the FAA and designed to protect personnel in accident situations are evaluated. The studies include evaluating injury mechanisms that might result from system failures or from hazardous conditions such as smoke or toxic gas environments. The studies support rulemaking or certification actions by developing performance standards and evaluating the merits, deficiencies, costs, and benefits of specific safety–related procedures and appliances. The same research generates educational spinoffs that, in cooperation with industry and airspace users, guide the aviation participant in the optimal use of safety equipment or procedures.

This project consists of three research initiatives: human protection and survival; medical and toxicological factors of accident investigation; and Federal Air Surgeon program support. Protecting humans in decelerative environments, protective breathing equipment, cabin evacuation, and water survival are currently being investigated in the human protection and survival initiative. Toxicological assessment and sudden or subtle pilot incapacitation are key features of the medical and toxicological factors of accident investigation initiative. New vision corrective methods for aviation personnel, radiation hazards, new antihypertensive treatments for pilots, and air ambulance medical requirements represent current clinical investigations under the Federal Air Surgeon program support initiative.

Related Projects: 061–110 Aircraft Systems Fire Safety and 062–110 Advanced Materials/ Structural Safety.

Products:

- Quantitative bioengineering criteria to support aircraft seat and restraint system certification
- Quantitative biomedical criteria to support protective breathing equipment and operational procedures certification
- Quantitative biochemical and toxicological criteria supporting the use or certification of aircraft interior fire, smoke, and toxicity limits
- Quantitative biomedical criteria to support flotation and onboard rescue equipment certification
- Revised aircrew medical criteria, standards, and assessment procedures
- Identifying medical causative factors in aviation incidents and accidents
- Occupational health assessments for unique populations in the aviation community

1995 Accomplishments:

- Develop new techniques to reduce head injury in aircraft crashes.
- Develop standards to prevent cervical spine injuries.
- Develop recommendations for standardizing supplemental oxygen use at lower altitudes.
- Develop safer aircraft cabin evacuation approval guidelines through international Federal Aviation Administration/Joint Aviation Authority research.
- Introduce automated cognitive function testing for pilot medical certification.
- Complete aircraft cabin air quality assessments in cooperation with the National Institute of Occupational Safety and Health.
- Develop guidelines for special issuance medical certificates.

Planned Activities:

<u>Human Protection and Survival</u>

In 1996, data will be developed to help prevent injuries to children in crashes. This data will improve compliance with existing crashworthiness regulations and assist the FAA in developing new certification criteria based on technology improvements. Also in 1996, research on protective breathing gear will continue. A key emphasis will be on conducting long–term research to improve high altitude breathing equipment biomedical standards by 1997. A prototype improved general aviation oxygen mask will also be developed by 1997, with an operational model available in 1999.

In 1996, work will continue on emergency medical equipment in air carriers, leading to a regulation update by 1997. Air ambulance equipment and crashworthiness requirements will be evaluated beginning in 1996. Criteria for selecting medical equipment will be developed in 1998. Further analyses on crashworthiness and electromagnetic interference will continue through 2002. Annual recommendations will be provided to the Aircraft Certification Service for developing standards.

In 1996, a prototype computer model for single aisle evacuations will be developed. This model will serve as a design and regulatory compliance tool. With model validation, it will be possible to eliminate cabin evacuation demonstrations that expose human subjects to dangerous test conditions. In 1996, a dual aisle evacuation capability will be introduced with special certification guideline development targeted for 1999. In parallel, development will begin in 1997 on a dual aisle emergency evacuation model, with first prototype expected in 2000 for possible implementation in 2002. Between 1998–2009, evacuation models will be developed for future aircraft, such as the high-speed civil transport and 800–plus passenger aircraft, that are iterations of the dual and single aisle models.

<u>Medical and Toxicological Factors of Accident Investigation</u>

In 1996, field clinical research to determine causative human factor elements in aircraft accidents will continue. The FAA Office of Accident Investigation continually requires this data to complete its investigations of complex and diverse aircraft accidents.

In 1997, a tool will be developed to permit toxicologists to determine whether alcohol detected in accident victims was ingested or was generated postmortem. This data will clarify medical and legal uncertainties surrounding an accident's cause. In 1996, an analysis will begin on the role of benzodiazepines and antihistamines in accident causation, with results published in 1997. Long–term research is targeted at developing updated guidance for using over–the–counter

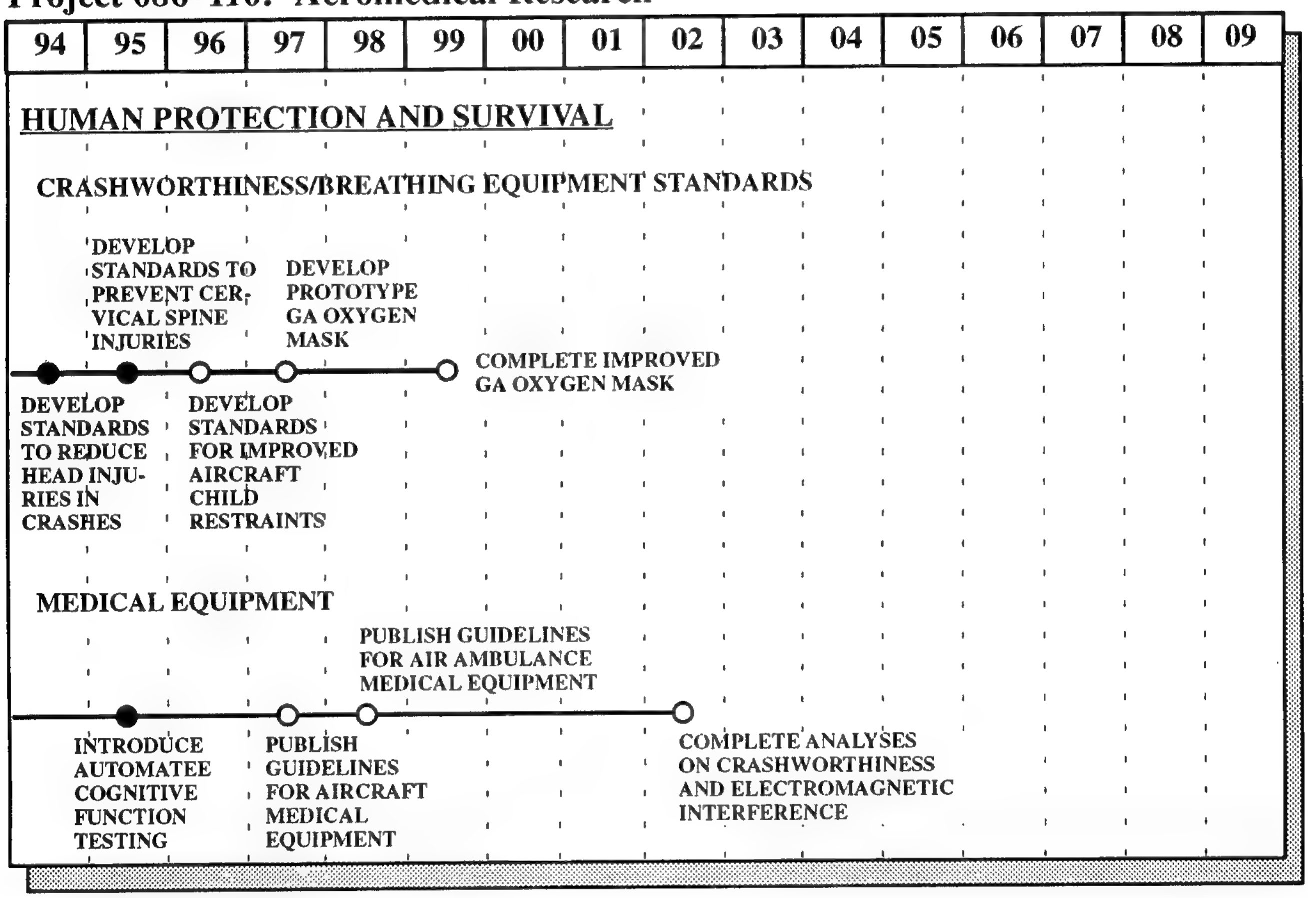
and prescription medications by civil aviation pilots in 1998.

Federal Air Surgeon Program Support

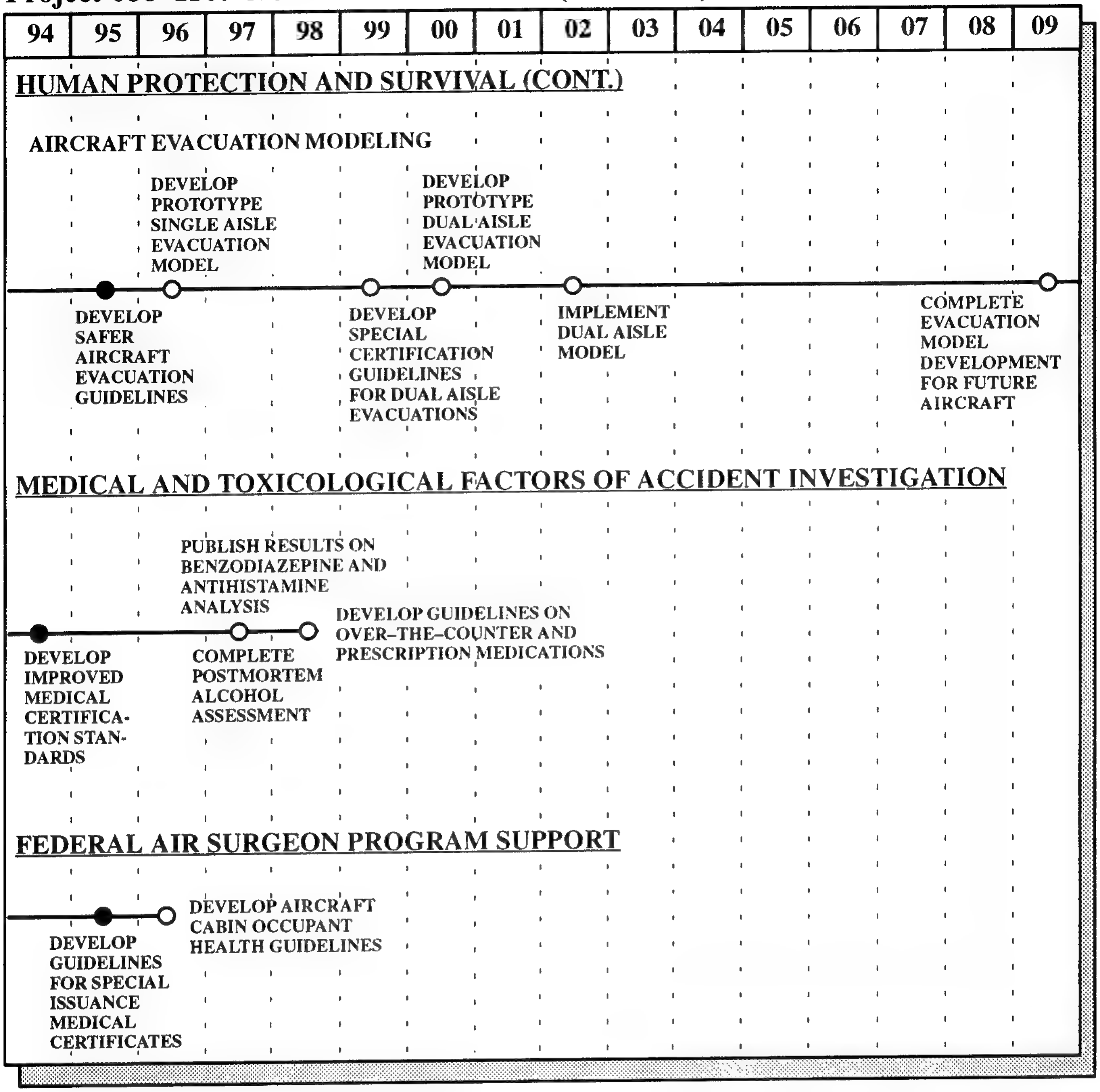
By 1996, joint FAA/National Institutes of Occupational Safety and Health research into cabin crew occupational health will determine the need for new guidelines to protect aircrew members.

Other long–term research to support the FAA's mission necessitates ad hoc studies on seat and restraint systems; optimizing aircraft exit configurations; maintaining cabin safety and anthropometry databanks; assessing human factors in aircraft accident causation; performing toxicity studies; profiling chemical abuse in aviation; examining effects of drugs and physiological stressors on performance; evaluating new vision corrective devices; and testing medical equipment in civilian aircraft.

Project 086–110: Aeromedical Research



Project 086–110: Aeromedical Research (continued)



087–110 Workforce Performance Optimization

Purpose: This project addresses agency–wide performance issues associated with reducing management levels; introducing new technologies into the workplace; and balancing the workforce in terms of ethnicity, age, and gender. Additionally, this project provides a structure for conducting research in managerial innovation and automation that will lead to enhancements in human performance. Research will enable the FAA to make tailored, research–

based decisions on these key human factors issues to promote an orderly, efficient, and cost–effective transition to the future workplace. Subtasks are prioritized by operational sponsors within the FAA to ensure maximum responsiveness to meet top priority FAA requirements.

Approach: FAA–wide human factors issues will be addressed by two major research thrust areas. The first research area supports developing programs that improve supervisor/managerial selection, training, and performance. The second area analyzes organizational systems and procedures to identify methods that can enhance individual, team, or workgroup performance. Research in this thrust area also will provide design strategies for an effective, efficient transition to future changes in the workplace. Emphasis will be on field research and experimentation, as opposed to laboratory methods, to ensure optimal transition of knowledge and products to the workplace.

All project activities are coordinated with Government agencies and private sector corporate representatives having related technical interests. Coordination among agency performing organizations and federally funded research centers is continuous. This coordination is a requirement in all FAA R,E&D reviews involving priorities and resource allocation.

Research approaches will consist of: (1) analytic organizational systems modeling to forecast the impact of new technology on workforce performance; (2) assessing managerial effectiveness to determine the impact of innovation on optimizing workforce performance; and (3) evaluating training and personnel programs to establish their cost-effectiveness in achieving workforce performance improvement objectives.

This project's human factors information will be used directly by operational organizations to develop improved programs and procedures for employees to work individually, or as teams, in response to the changing workplace and new requirements. Recommendations for enhancements in selecting, training, and developing supervisory and managerial personnel will provide the basis for an organization that optimizes individual and team performance.

Related Projects: This project has potential applications across the entire R,E&D spectrum.

Products:

- Methodologies to assess organizational performance baselines for forecasting new technology impacts

- Training requirements forecasts to optimize the operation and maintenance of new workplace technologies

- Assessments and recommendations for managerial innovations to improve workforce performance and safety

- New system cost–effectiveness evaluations designed to enhance workforce performance

1995 Accomplishments:

- Validate aircraft certification service supervisor selection program.

- Develop diversity training awareness recommendations.

- Validate improved job satisfaction survey (JSS) methodologies.

- Complete recommendations for cross–functional teaming.

Planned Activities:

Supervisor/Managerial Selection, Training, and Performance

In 1996, supervisor selection and performance criteria will be validated for the Air Traffic Service. Outcomes from the initial selection system validation using new performance criteria will be completed in 1997. Recommendations for an overall model to validate FAA supervisor and managerial selection systems will be completed in 1998, followed in 1999 by generic selection and performance criteria for FAA managers. Specific management selection criteria will be developed in 1999 with executive selection criteria planned for 2002. Task analyses to identify supervisory competencies required beyond 2000 will be completed in 2001. Subsequent research will identify and validate selection and performance criteria for those positions through 2004. Further efforts will be required to ensure that future supervisory selection programs evolve with changes in technology and the agency's organizational structure and mission.

In 1996, research will assess the impact of revisions to the FAA initial supervisory training curricula. In 1997, first stage operational team training evaluations for selected Agency organizations such as flight inspection aircrews, air traffic controllers, and acquisition managers will be completed. This research will lead to recommendations for enhanced team, team leader, and manager training models in 1999 and enhanced executive training in 2002.

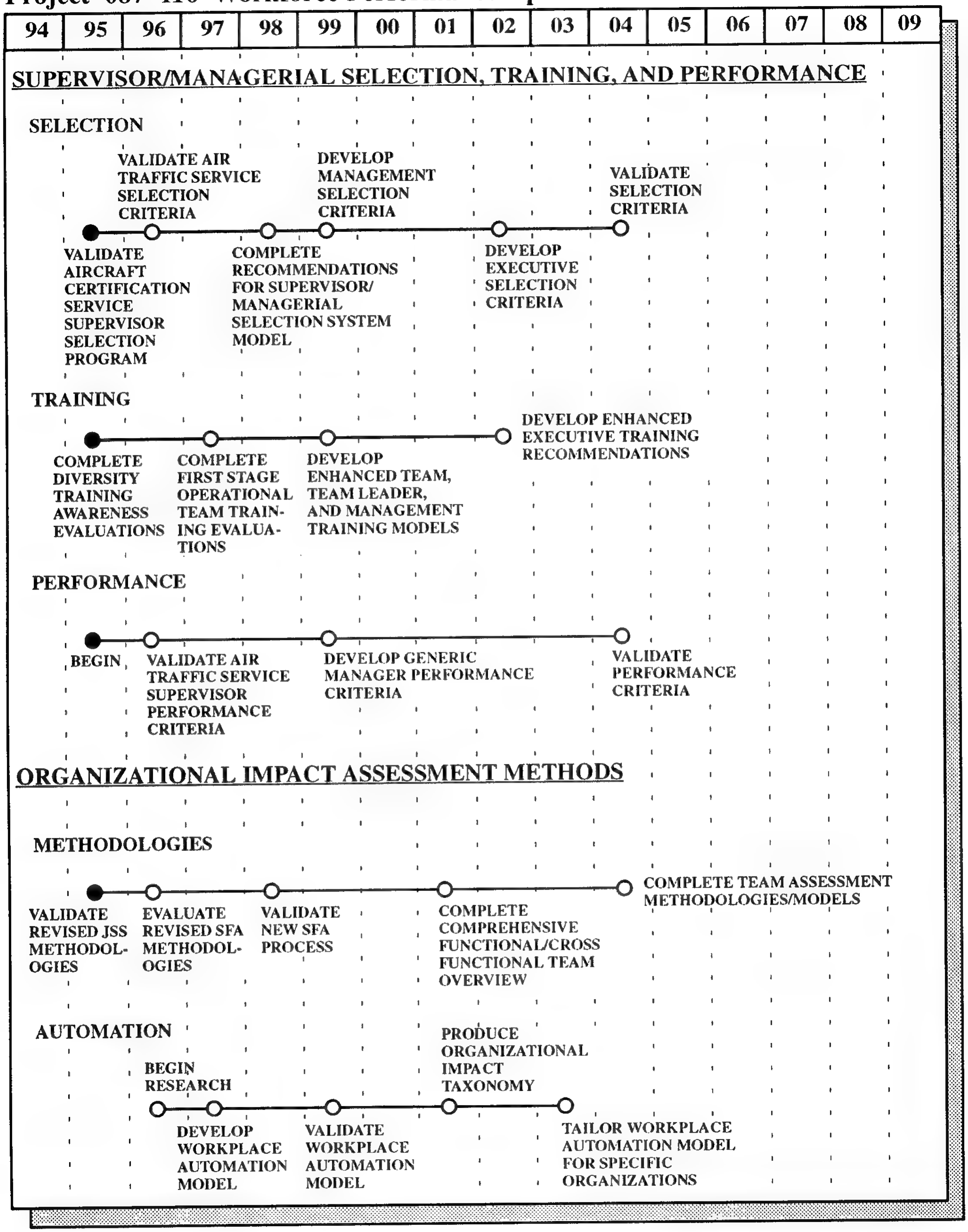
Organizational Impact Assessment Methods

A key objective in this research area is assessing the FAA's downsizing impact on workforce performance. In 1996, the JSS will continue on a biennial basis to explore ways new technical capabilities can enhance survey information value and expand access to results. In 1996, the impact of revised survey feedback action (SFA) methodologies will be evaluated for their utility in enhancing FAA work team effectiveness. In 1998, the new SFA process will be validated.

In 1997, a methodology will be completed for FAA managers to use in assessing the impact of total quality management initiatives. This methodology will support research–based management decisions on adopting total quality management initiatives affecting customer service satisfaction. By 2001, a comprehensive overview will be provided describing the functional and cross–functional teams' impact on performance within various types of organizations. Subsequent research will be completed in 2004 on team assessment methodologies leading to team assessment models that account for future advances in electronic communications, telecommuting, and other types of teaming capabilities.

In 1998, research efforts will culminate in a dynamic human factors model for introducing workplace automation. In 2000, methodologies will be developed and proven on several office automation projects for the Information Technology Office, and the automation model will be validated. In 2002, research efforts will produce a taxonomy of organizational impact factors affected by automation that will forecast potential barriers to effective automation implementation. In 2004, a methodology will be developed to tailor the generic dynamic human factors model to specific automation applications, such as ATC work stations or AF system management.

Project 087–110 Workforce Performance Optimization



9.0 ENVIRONMENT AND ENERGY

Research, Engineering and Development (R,E&D) projects in this thrust area support national goals to protect the environment, conserve energy, and keep the U.S. air transportation industry strong and competitive. In 1995, approximately 1.7 million individuals live within areas considered to be exposed to significant airplane noise (a day–night average sound level of 65 decibels or more) and more than 400 U.S. airports have adopted some type of airport restriction to reduce aircraft noise or mitigate its effects. In some cases these restrictions have little impact on airport capacity, but in others the potential airport capacity has been reduced by as much as 30 percent. While there is an effort underway to ensure an early phaseout of older, noisier aircraft, there will clearly be a demand for even more stringent limitations on aircraft noise. Air pollution from aircraft is also becoming a major concern in airport expansion and proposed new airport construction. New aircraft and new aircraft engine types offer potential relief to the public; however, substantial R,E&D will be required to support future regulations.

The future aviation system will be one that is a "good neighbor" to the people living near airports. The challenges revolve around issues associated with how this good neighbor policy is implemented. While noise and pollution are the primary challenges, other issues associated with the atmospheric effects from new aircraft types, and new or alternative fuels, will require analysis and investigation.

The value gained from projects in this thrust area will derive from reducing both direct and indirect costs associated with meeting the national goals. Discovering ways to build quieter engines that have fewer noxious emissions is the direct approach. The indirect approach is to develop ways to use existing equipment more appropriately. Both approaches are reflected in this thrust area's projects.

A benefits assessment associated with these projects is underway. Noise reduction assessment strategies will be built around meeting local noise restrictions in ways that have less impact on airport capacity and, therefore, on system delays.

The FAA's policy for environment and energy issues is to provide strong leadership in mitigating aviation's adverse impact on the public, consistent with sound energy planning and an effective aviation system. The FAA has adopted the following strategies:

- Lead a cooperative development effort that balances noise reduction with adequate airport capacity.
- Manage FAA activities to minimize adverse environmental consequences and comply with all federal statutes.
- Develop sound aviation energy plans.
- Stimulate private industry and Government–sponsored research to reduce noise, emissions, and energy consumption by the aviation sector.

The Research, Engineering and Development Plan for the Environment and Energy thrust area responds directly to these strategies, and to the recently passed Airport and Airway Safety, Capacity, Noise Improvement, and Intermodal Transportation Act of 1992, and the Clean Air Act Amendments of 1990.

Through joint efforts with industry, the FAA will improve regulatory standards for noise and air pollution. It will also develop better technologies for predicting, measuring, and abating the environmental impact from aircraft emissions. Research will help define global standards for noise and air quality that are now being developed by the International Civil Aviation Organization.

9.1 Environment and Energy Project Descriptions

091–110 Environment and Energy

Purpose: This project will develop various tools and methods used to evaluate the environmental impact from alternative aviation policies and strategies. The focus will be on aviation noise, a major constraint on airway and airport capacity, and air pollution/aircraft emissions in the upper atmosphere, a growing public concern. The project will also ensure FAA compliance with all federal environmental statutes, such as the Airport and Airway Safety, Capacity, Noise Improvement, and Intermodal Transportation Act of 1992 and the Clean Air Act Amendments of 1990.

Approach: Environment and Energy R,E&D consists of the following major disciplines: aviation environmental analysis; aircraft noise reduction and control; aircraft engine emissions reduction and control; and FAA energy conservation and aviation energy emergency contingency planning.

Aviation Environmental Analysis

The aviation environmental analysis and the aircraft noise reduction and control activities will eliminate many constraints on aviation growth, especially on airport capacity, through technology and expertise aimed at mitigating or controlling aircraft noise. These activities will include continually updating and improving the integrated noise model (INM), the heliport noise model (HNM), the area equivalent method (AEM), and the nationwide airport noise impact model. These noise models are used to predict and assess the impact from FAA policies and federal actions. Research will be conducted to develop better tools for assessing the costs and benefits associated with noise reduction and control activities.

A cooperative research program with the National Aeronautics and Space Administration (NASA) will investigate human response to noise levels and frequencies as part of a longer range program aimed at developing a better understanding of community response.

Aircraft Noise Reduction and Control

The FAA has entered into a joint research program with NASA research centers to investigate technology advances in source noise reduction. The research will include engine design parameters, advanced acoustic absorption materials, and active noise control devices. Aircraft technology advances will include high lift devices and methods to reduce airframe–generated noise.

Noise testing will be conducted to simplify existing certification procedures and develop new procedures for future aircraft. Noise requirements for heavy helicopters, advanced subsonic transports, high-speed civil aircraft, and hypersonic research vehicles will be evaluated in cooperation with industry.

Aircraft Engine Emissions Control

The FAA will undertake a joint high altitude pollution research program with NASA's research centers to investigate new technologies in jet engine combustor designs that reduce engine emissions, specifically nitrogen oxide emissions. These emissions generate particular concern due to their potential impact on the upper atmosphere. The results from these investigations will be used in developing future engine emission regulations and international standards. Studies with NASA will also investigate both current subsonic and high–speed civil transport's (HSCT) effect on the

ozone layer and global climate change. These studies are intended to determine the HSCT's future viability and the need for aircraft engine emission standards at cruise altitude conditions.

Energy Conservation and Aviation Energy Emergency Contingency Planning

This project will support achieving a 20 percent energy use reduction or a 20 percent increase in efficiency in FAA buildings by 2000 as compared to 1985. It seeks to minimize energy use in federal facilities to comply with Executive Order 12759. The FAA also will review and evaluate the present energy management reporting system. Based on this review, the system will be upgraded and enhanced, or replaced with another tracking and reporting system. A user training program will also be developed. The reporting requirement is mandated by Executive Order 12759 and the National Energy Conservation Policy Act, as amended.

The FAA Aviation Energy Emergency Contingency Plan will also be reviewed and updated. An aviation energy statistics/fuel survey will be developed, and a method to continually update the data base will be incorporated in the plan. Energy support studies will be conducted as required to support the plan.

Related Projects: 021–220 Multiple Runway Procedures Development, 024–110 Aviation System Capacity Planning, and 025–130 Air Traffic Models and Evaluation Tools.

Products:

- Mathematical models to compute the impact from aviation noise for both airports and heliports
- Mathematical models to compute aviation contributions to airport and upper atmospheric air pollution
- New, simplified aircraft certification procedures for contemporary airplanes and helicopters used to revise certification regulations
- Handbooks and guidance material for FAA field personnel involved in aircraft certification
- Certification standards for new technology aircraft including ultra high–bypass engines and HSCT's used to promulgate new regulations
- Studies to identify feasible technologies leading to potential noise certification standards
- Improved FAA energy contingency plan and computerized reporting system to meet FAA and Department of Energy reporting obligations to Congress
- Revised and updated Advisory Circular 36, Aircraft Noise Levels

1995 Accomplishments:

- Develop contingency/emergency preparedness plan to comply with Executive Order 12759 on energy conservation, planning, and reporting obligations.
- Develop engine emissions certification training course.
- Publish AC34–1, Emission Levels for U.S. Certified and Foreign Turbojet Engines.
- Release improved rotorcraft noise prediction tool (HNM version 3.0).

Planned Activities:

Aviation Environmental Analysis

In 1996, a system of airport noise analyses and impact assessment tools and processes will be developed. These tools and analyses will be used to: identify optimal airport development alternatives, avert public controversy, and accommodate federal guidelines. This system will be expanded in 1998 to include major air traffic management and airspace improvement projects. In 1998, research will begin on developing a non-airport noise assessment prediction capability. A prototype noise assessment tool will be developed in 2000 for field validation in 2002, followed by distribution in 2003.

Aircraft Noise Reduction and Control

In 1997, simplified noise certification procedures will be developed for large helicopters. Also, vertical flight noise assessment tools will be completed for use in heliport/vertiport development. From 1996–2000, the FAA/NASA research effort assessing subsonic jet noise reduction technologies will continue. Annual reports will be published to describe results, track project progress, and identify promising technologies. In 2000, the research will identify economically feasible technologies for U.S. manufacturers to develop quieter airplanes.

In parallel with the aircraft noise research, starting in 1996 and continuing through 2003, an FAA/NASA research effort will assess rotorcraft noise reduction technologies. Annual reports will be published to describe research results, track project progress, and identify promising technologies. In 2003, research will identify economically feasible technologies for U.S. manufacturers to develop quieter helicopters.

Aircraft Engine Emissions and Control

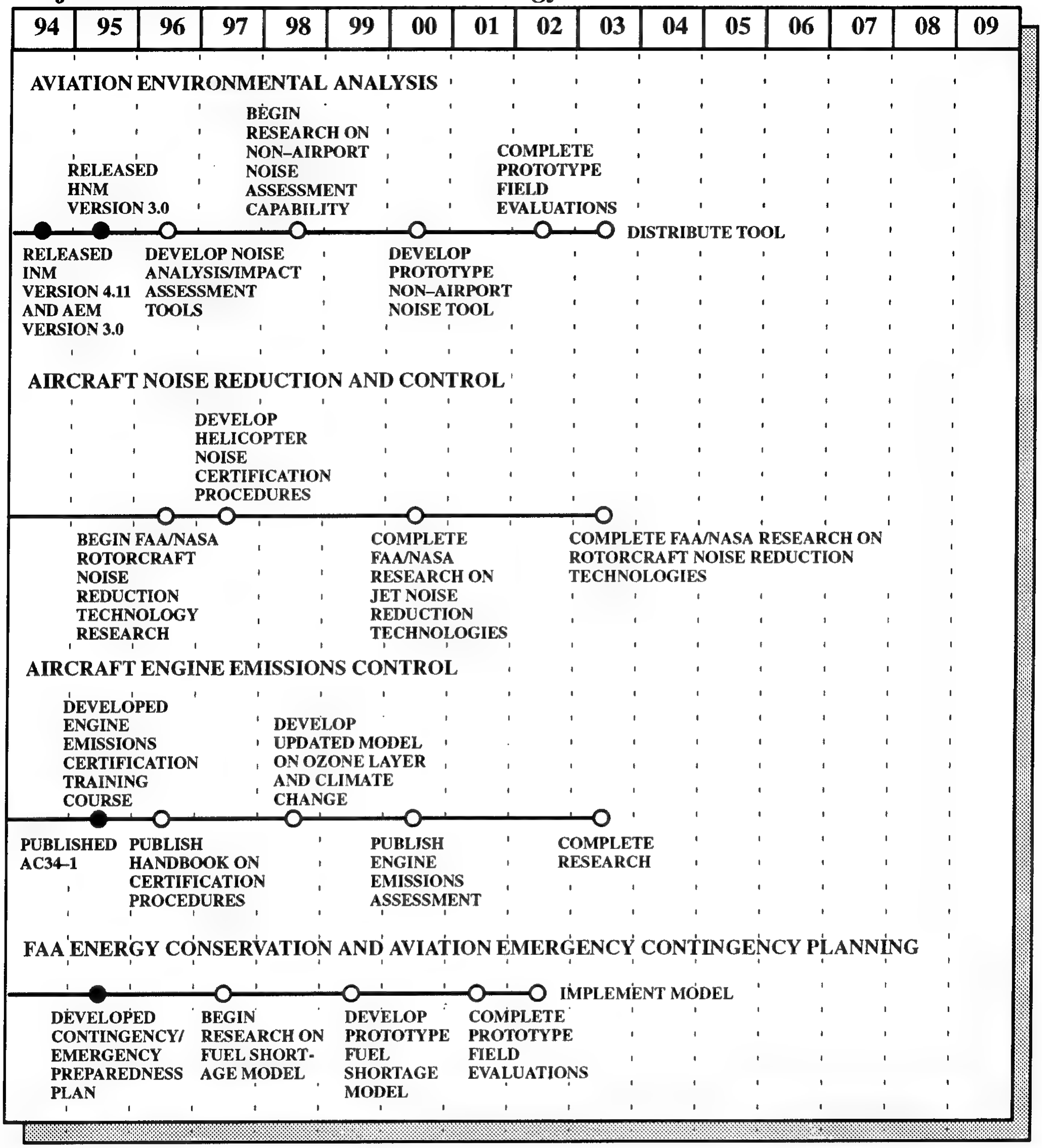
In 1996, the FAA will issue a handbook on engine emissions certification procedures. To ensure consistency with known changes in the Clean Air Act, the FAA will update the Federal Aviation Regulations on aircraft emissions in 1998. The FAA's data base on emissions characteristics will be expanded by collecting data on new technology and newly certified engines.

In 1998, an updated version of the global aircraft emissions forecasting model will be developed to predict the atmospheric effects from subsonic and HSCT emissions on the ozone layer and global climate change. An assessment will be published in 2000 with research continuing through 2003 to develop new engine emissions technologies. The final product will be using these analyses and research efforts to develop engine emissions certification standards and other regulatory actions.

Energy Conservation and Aviation Emergency Contingency Planning

In 1997, work will begin on developing an aviation fuel shortage forecast and assessment model. This model will support contingency planning and emergency preparedness during a national fuel crisis. In 1999, a prototype model will be developed with field evaluation completed by 2001. In 2002, the model will be ready for implementation.

Project 091–110: Environment and Energy



APPENDIX A

Innovative/Cooperative Research

The Federal Aviation Administration's Research, Engineering and Development (R,E&D) program is committed to supporting a technologically advanced future aviation system. The agency's Innovative and Cooperative Research program provides vehicles to test new and innovative ideas to implement the vision while satisfying congressionally mandated research requirements.

The cornerstones of the program are the Aviation Research Grants and the Technology Transfer programs. The Aviation Research Grants Program is integral to the FAA's comprehensive R,E&D Plan. Grants allow the FAA to expand its technology base by accessing the substantial research capabilities of leading colleges, universities, and other research institutions. Grant projects focus on research necessary to the FAA's mission to improve aviation safety, security, capacity, and the environment.

Technology transfer is the process by which knowledge, facilities, or capabilities developed by federal laboratories or agencies are transferred to the private sector to expand the U.S. technology base and to maximize the return on investment in federally funded research and development. Technology transfer is a critical tool designed to help the private sector meet the challenges of the highly competitive global economic environment. The instrument utilized by the Technology Transfer Program is the Cooperative Research and Development Agreement (CRDA) between federal agencies and private companies.

In addition, the University Fellowship Program gives students and their professors the opportunity to become involved in a broad spectrum of programs at the Technical Center. This program has led to recruiting highly qualified students for the FAA. The FAA/National Aeronautics and Space Administration (NASA) Cooperative Program allows sharing research that benefits both agencies. The Transportation Research Board is an FAA link to the National Academy of Sciences which sponsors workshops and awards individual fellowships through the Graduate Research Award Program.

Through research grants, cooperative agreements, and small business contracts, the FAA exploits outside expertise and encourages academic, industrial, and other Government agency participation that benefits the R,E&D program.

101–110 Transportation Research Board (TRB)

Purpose: This program stimulates research concerning the nature and performance of aviation transportation systems, disseminates the information produced by the research, and encourages applying appropriate research findings. This research influences the FAA's future policy direction. The TRB is a National Research Council unit that serves the National Academies of Sciences and Engineering. The products from this research help the public sector focus on technical and management innovations developed by the academic and private sectors to resolve current and future critical issues. The TRB also provides an independent perspective on means that

could be used to improve safety, manage the national aviation system, increase capacity and productivity, and stimulate interest in highly qualified students to pursue careers in aviation.

Approach: The FAA determines specific research to be conducted and awards research contracts to the TRB. This program is carried out largely by committees, task forces, and a panel staffed by industry, public officials, and university experts who serve without compensation. The FAA provides one or more analysts to participate on these committees, task forces, and panels. The Board's efforts also include research on aviation's future by conducting an annual Graduate Research Award Program. This program focuses on technical and management innovations for civil aviation facilities in the next century and other special research projects to further the national aviation system's safety and efficiency. Completed products are normally transmitted to the FAA, industry, and general public as an official TRB circular. The Graduate Research Award Program papers are also presented at a special session of the annual TRB meeting.

101–120 FAA/NASA Joint University Program

Purpose: This program conducts research germane to the entire spectrum of National Airspace System (NAS) activities at recognized American universities in cooperation with NASA. It also assists in educating professional personnel needed to develop and manage the future NAS components. Solutions to large scale systems problems related to the national air transportation system ultimately come only after the technological foundations have been laid through basic research. The Joint University Program has provided an interdisciplinary team approach to research and education in those areas necessary for fundamental advances at the forefront of aviation technology. This program provides results to the FAA from scientific and technology advances through research and development at American colleges and universities. Also, the program is a source of talented engineers and scientists skilled in aviation–related fields.

Approach: The FAA/NASA Joint University Program for Air Transportation Research is a coordinated set of three grants sponsored jointly by the FAA and NASA Langley Research Center. Grants are awarded annually to the Massachusetts Institute of Technology, Ohio University, and Princeton University. Principal investigators at each institution prepare an annual research proposal that is based, in part, on suggested topics that are responsive to FAA and NASA long–term needs. The principal investigators are responsible for assembling the research teams, managing the research, and publishing the results. Four technical conferences are held per year at the FAA, NASA, and participating universities. The outcome of the research is published in numerous technical papers and an annual report.

101–130 Small Business Innovative Research (SBIR) Program

Purpose: This program stimulates technological innovation, uses small business to meet federal research and development needs, increases private sector commercialization of

innovations derived from federal research, and encourages participation by small disadvantaged companies in developing technological innovations. The SBIR program is congressionally mandated by the Small Business Research and Development Enhancement Act of 1992 (Public Law 102–504). The program is funded through project funds that reside in other R,E&D programs. By virtue of its FAA–wide scope, the SBIR program benefits the entire program spectrum that makes up the national air transportation system. The budgetary and technical resources can be applied to these programs in a timely and cost–effective manner. By enabling small, high technology corporations to start up and prosper, the SBIR contributes in a larger sense to the domestic economy and technology infrastructure.

Approach: Research topics are solicited from the various organizational elements throughout the agency. These topics then appear in an annual solicitation for proposals issued by the Department of Transportation. Individuals who submit the topics evaluate the proposals, and winners are chosen based on evaluations and agency needs. Firms selected to receive an award embark on the following three–phase process: Phase I – conduct feasibility–related experimental or theoretical research for R,E&D efforts up to $75,000; Phase II – perform principal research effort (a performance period of approximately 2 years and funding up to $500,000); and Phase III – perform commercialization of the research conducted under Phases I and II.

101–140 FAA/NASA Cooperative Programs

Purpose: This program provides a synergistic and cost–effective R,E&D program with NASA in areas of mutual interest. FAA engineering field offices have been established at NASA's Ames and Langley Research Centers to support joint FAA/NASA programs and provide coordination on aviation–related NASA work. The FAA engineering field offices represent a unique resource for the FAA due to their proximity and access to NASA facilities, their knowledge of NASA personnel and ongoing NASA research, and their understanding of FAA needs. Benefits realized when the agencies work together include an enhanced perspective on joint research activities, reduced duplication of similar efforts, and conservation of scarce funds and resources.

Approach: Cooperative activities are accomplished via memorandums of agreement that incorporate statements of work setting forth specific research thrusts. Joint research activities are performed via memorandums of understanding that set forth general areas for cooperative endeavor. Individual research programs are negotiated and undertaken in a manner tailored to meet program–specific objectives, foster cooperative interaction, and share resources and unique facilities. The memorandums of understanding address Human Factors, Severe Weather, Cockpit/Air Traffic Control (ATC) Integration, Airworthiness, Environmental Compatibility, and Program Support.

Human factors research develops technology to reduce the consequences of human error in flight operations. Severe weather research improves aircraft operational safety during hazardous weather conditions. Cockpit/ATC integration research improves flight operations safety and efficiency. Airworthiness research pursues technologies that support developing and certifying new aircraft and ensure the continued safe operation of existing aircraft. Environmental compatibility research reduces or eliminates aircraft noise and emission concerns. Program support conducts individual and joint research activities, shares in using unique facilities, and plans orderly information transfer between the two agencies.

101–150 University Fellowship Research Program

Purpose: This program expands the education and research activities associated with emerging concepts and technologies related to air traffic control, aviation safety, and security systems. A corollary purpose is to assist in attracting and recruiting qualified graduates to work for the FAA. The University Fellowship Research Program gives well-qualified and highly motivated graduate students an opportunity to conduct thesis research on FAA topics of interest while working with FAA engineers, scientists, and university professors. This program provides technology advancements to enhance the National Airspace System capability and improve aircraft safety and security. Educational opportunities will be provided for talented engineers and scientists with the skills, interests, and abilities necessary to accomplish this work. Opportunities will exist to recruit these and other talented, qualified graduates to work for the FAA.

Approach: Participants in the program engage in formal course work at their respective universities and conduct research in FAA laboratories on FAA–directed topics. The program includes expanding universities' education and research activities in areas related to air traffic control systems and aircraft safety. Companion education and training activities are included to develop and enhance existing capabilities within the FAA.

101–160 Technology Transfer Program

Purpose: This program promotes technology sharing among Government, industry, and academia, and it transfers FAA R,E&D results into the mainstream of the United States economy. Technology transfer refers to the process by which existing knowledge, facilities, or capabilities developed under federal funding are used to fulfill public or private domestic needs. The United States is facing increasing challenges to its worldwide technical and economic primacy. A major problem in meeting these challenges is the extremely small return on the $60 billion annual federal research and development investment. The central obstacle to increasing this return has been identified by Congress as the federal Government's inability to transfer a significant portion of federally funded research and development results into the private sector for commercialization. Several key pieces of legislation have been enacted to overcome this obstacle.

The Stevenson–Wydler Technology Innovation Act of 1980 (Public Law 96–480) mandated that all federal laboratories assume technology transfer as a primary mission area. It provided the legal foundation for a technology transfer infrastructure within the federal laboratory system and established an Office of Research and Technology Applications at every federal R&D activity.

The Technology Transfer Act of 1986 (Public Law 99–502) established the formal tools and mechanisms to accomplish technology transfer and mandated the following elements: (1) establish cooperative research and development agreements (CRDA) between federal and non-federal parties; (2) establish the Federal Laboratory Consortium, an affiliation of Government laboratories to support the technology transfer mission; and (3) provide a cash incentive program to promote and encourage individual participation in meaningful technology transfer projects through awards and royalty sharing.

Executive Order 12591 of April 10, 1987, directed all federal laboratories to establish

Technology Transfer Programs. In response to the laws and the Executive Order, the FAA developed Technology Transfer Order 9550.6 of October 30, 1989, which promulgates the FAA's Technology Transfer Program.

Approach: The FAA Technology Transfer Program goals are to: increase the return on the federal R&D investment, increase the Nation's base for technical knowledge and experience, translate technical developments into private sector applications, reward technical creativity, and comply with the letter and the spirit of federal technology transfer legislation.

101–170 Independent Research and Development (IR&D) Program

Purpose: This program encourages contractors to perform independent research and development on topics relevant to the FAA's long–term interests. This activity is a joint Government/industry program legislated by Public Law 102–190.

The Government recognizes IR&D as a necessary cost of doing business in a high technology environment and provides for cost recovery in the Federal Acquisition Regulations. Major contractors doing IR&D projects are requested to provide the FAA with information describing these projects. Descriptions also are submitted to the Defense Technical Information Center (DTIC) on a yearly basis in the prescribed format.

New IR&D legislation no longer requires yearly on–site review evaluations, but encourages IR&D technical interchange meetings. These meetings are arranged by mutual agreement between the contractor and Government to review and discuss a focused set of technology and/or product development projects. The purpose of these meetings is to: promote face–to–face detailed technical interaction between the contractors and the Government; provide opportunities for Government presentations on relevant technical needs and activities; and provide opportunities for Government participants to visit the contractor's facilities and operations.

The IR&D program's benefits are:

- Access to industry views about technical and business directions for the future.
- A broader range of technical options in an R&D project's early phases.
- An available pool of qualified contractors who can respond competently and competitively to Government requirements.
- Spreading the risk and cost of encouraging new ideas and concepts.
- An enhanced capability for continuous innovation to meet technical challenges for the future.

Approach: The Office of Research and Technology Applications has access to the DTIC proprietary IR&D data base. During the year, customized data base searches are performed for the R,E&D services. Upon request, the IR&D program office will arrange technical interchange group meetings to explore any company's IR&D projects. Further contacts may then be made with the principal investigators to monitor the research results and their potential use to the FAA.

101–180 Aviation Research Grant Program

Purpose: This program provides the FAA with the ability to access and influence directly the considerable resources existing at American colleges, universities, and nonprofit institutions to perform long–term research in aviation–related technical areas. This capability is accomplished by awarding grants for aviation research and establishing Air Transportation Research Centers of Excellence. Two pieces of legislation, the FAA R,E&D Reauthorization Act Title IX, Public Law 101–508, and the Aviation Security Improvement Act, Public Law 101–604, were enacted and contain provisions authorizing the FAA to issue research grants. Public Law 101–508 establishes three separate programs: the Aviation Research Grants Program, the Catastrophic Failure Prevention Research Grant Program, and the Air Transportation Research Centers of Excellence Program. Public Law 101–604 authorizes establishing the Aviation Security Research Grants Program.

Collectively, the legislation directs that:

- The FAA be given the authority to award single and multiyear research grants to colleges, universities, and nonprofit institutions.
- The FAA be authorized to establish Centers of Excellence for research into aviation–related areas of unique interest to the FAA.
- Research areas shall cover, at a minimum, ATC automation, aviation artificial intelligence applications, aviation control simulation and training technologies, human factors, airport and airspace planning and design, airport capacity enhancement, aviation security, and aircraft safety.
- At least 3 percent of the total FAA R,E&D budget be devoted to fund the research grant program.
- The FAA shall contribute to creating a talented pool of technical professionals trained in the sciences, engineering, and mathematics, and mechanics related to aeronautics and aviation.

Approach: Program execution rests on a set of established internal and external procedures that are updated continuously. A process for advertising, soliciting, and evaluating program proposals was developed and initiated. This process, together with a companion process for awarding, administering, and closing out grants, is detailed in FAA Directive 9550.7, Aviation Research Grants. Computer data bases have been established to ensure that eligible institutions are notified of the program and that proposals and grant awards are properly tracked. A network of capable proposal technical evaluators and grant technical monitors has been put in place.

Fifty grant awards have been made during initial program operation. These grants are funded via individual program sponsorship. A Center of Excellence in Computational Modeling in Aircraft Structures was started in 1993 at Rutgers/Georgia Tech. Procedures for identifying and initiating follow–on Centers of Excellence have been defined and are about to enter the agency coordination process.

101–190 Innovation Development and Engineering Applications (IDEA) Program

Purpose: This program will provide the FAA with a formal structure to ensure that novel ideas for innovative R,E&D projects, proposed by FAA employees or the private sector, will be evaluated and, if feasible, sponsored. The FAA IDEA program is designed to expedite and facilitate technological innovation. This will be accomplished by sponsoring innovative applied research and engineering development projects, both in the FAA and the private sector, through a variety of implementation vehicles. This thrust area is expected to promote: an innovative R,E&D environment, new technology applications to FAA programs, an increase in FAA patents and licenses, increased access to private sector expertise, increased technology transfer, increased employee satisfaction, and total quality management implementation.

Approach: The approach to this program is to establish a focal point within the Office of Research and Technology Applications, ACL–1, that will have discretionary R,E&D funds available. This focal point will act as a catalyst to accomplish research on innovative ideas from within and outside the FAA. The IDEA program will utilize various vehicles such as grants, CRDA's, broad agency announcements, task–order contracts, employee exchange, total quality management, and employee temporary assignments to aid in timely implementation of these innovative ideas.

The criteria used to evaluate potential innovative research projects will include, but are not limited to:

- Projects that represent ideas or technologies that are promising and should be pursued but are outside the charter of the originating organization.
- Projects that are outside the stated responsibilities of a researcher's position description but seem promising and should be pursued for the FAA's benefit.
- Projects that are not feasible for an organization to pursue because of constraints imposed by time, current project workloads, limited manpower, financial resources, risk factors, or other such limitations.

An ad hoc "council of peers" consisting of experts in various technology areas will be recruited by the program and will serve in a consulting capacity to provide expert advice on proposed projects relating to technologies in their area of expertise. Based on the council's findings, a determination will be made on individual projects.

APPENDIX B

Research, Engineering and Development (R,E&D) Management, Plan, Control, and Support

A process was initiated in 1990 to provide more in–depth analysis and control for R,E&D activities. The process emphasizes developing a systems engineering approach to define, implement, and manage the research required for National Airspace System (NAS) development. This process' maintenance and enhancement is critical to the R,E&D program efficiency and effectiveness. Supporting the R,E&D infrastructure contributes to virtually every project within the R,E&D environment.

The R,E&D infrastructure provides the vehicle to ensure that the total R,E&D program is conducted as a cohesive, integrated entity and permits evaluating progress across the thrust areas. This is critical due to the integrated nature, both technical and fiscal, of the individual R,E&D projects with each other, with the future aviation system, and with the Aviation System Capital Investment Plan.

R,E&D resources are required for the following efforts:

<u>Research, Engineering and Development Plan</u>

The Aviation Safety Research Act of 1988 mandates that the FAA develop, maintain, and publish the FAA's R,E&D Plan. The Plan describes the R,E&D process, the relationships with other R,E&D organizations, the National Airspace System and its evolution, and the FAA's R,E&D program.

<u>R,E&D Management, Plan, and Control</u>

The R,E&D management and control process and automated support system will be maintained, refined, and further integrated into the R,E&D planning and budgetary processes. Specific products will include publishing the annual R,E&D Plan, associated report to Congress on R,E&D accomplishments from the previous year, technical/engineering schedule support for the R,E&D program, and the annual R,E&D conference.

<u>R,E&D Advisory Committee</u>

The committee will provide the agency with reports, advice, and recommendations regarding the needs, objective, plans, approaches, contents, and accomplishments with respect to the aviation research program. The committee considers aviation research needs to support the FAA mission and addresses such areas as airport capacity, system safety, aircraft safety, aeromedical research, aviation security, and future ATC technology.

<u>R,E&D Program Support</u>

Provides for in–house support for system engineering and development, international requirements, and NAS program analysis activities.

<u>Technical Laboratory Facility</u>

The FAA Technical Center operates and maintains laboratory facilities to perform test, evaluation, and integration efforts. Funding is required for maintenance, software licensing fees, support costs, and other costs associated with operating the technical laboratories.

APPENDIX C

List of Acronyms and Abbreviations

A

AAS	Advanced Automation System
AC	Advisory Circular
ACE	Aviation Capacity Enhancement
ACL	The FAA's Office of Research and Technology Applications
ADL	Aeronautical Data Link
ADR	Automated Demand Resolution
ADS	Automatic Dependent Surveillance
AEEC	Aeronautical Electronics Engineering Committee
AEM	Area Equivalent Method
AERA	Automated En Route Air Traffic Control
AF	Airway Facilities
A/G	Air/Ground
AMASS	Airport Movement Area Safety System
AMSS	Aeronautical Mobile Satellite Services
AOAS	Advanced Oceanic Automation System
AOC	Airline Operations Center
APMS	Automated Performance Measurement System
AQP	Advanced Qualification Program
ARINC	Aeronautical Radio, Incorporated
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASDE	Airport Surface Detection Equipment
ASI	Aviation Safety Inspector
ASR	Airport Surveillance Radar
ASTA	Airport Surface Traffic Automation
ATC	Air Traffic Control
ATCSCC	Air Traffic Control System Command Center
ATIS	Automated Terminal Information Service
ATM	Air Traffic Management
ATMS	Advanced Traffic Management System
ATN	Aeronautical Telecommunications Network

AWDL	Aviation Weather Development Laboratory
AWOS	Automated Weather Observing System
AWPG	Aviation Weather Products Generator

C

CASA	Controller Automation Spacing Aid
CAT	Category
CDTI	Cockpit Display of Surface Traffic Information
CHI	Computer/Human Interface
CIP	Capital Investment Plan
C/N/S	Communications, Navigation, and Surveillance
CONDAT	Conterminous United States Data Access Tool
CRDA	Cooperative Research and Development Agreement or Converging Runway Display Aid
CSD	Critical Sector Detector
C/SOIT	Communications/Surveillance Operational Implementation Team
CTAS	Center–TRACON Automation System
CTR	Civil Tiltrotor

D

DA	Descent Advisor
DARP	Dynamic Aircraft Route Planning
DDAS	Daily Demand Analysis System
DEM/VAL	Demonstration/Validation
DGPS	Differential corrected Global Positioning System
DME	Distance Measuring Equipment
DOD	U.S. Department of Defense
DOTS	Dynamic Ocean Track System
DSS	Decision Support System
DTIC	Defense Technical Information Center

E

EDP	Expedite Departure Path
EDPRT	Expert Diagnostic, Predictive, and Resolution Tools
EFF	Experimental Forecast Facility
ETMS	Enhanced Traffic Management System
EWR	ICAO Designator for Newark Airport

F

F&E	Facilities and Equipment
FAA	Federal Aviation Administration
FANS	Future Air Navigation System
FAR	Federal Aviation Regulations
FAST	Final Approach Spacing Tool
FBL	Fly–By–Light
FBW	Fly–By–Wire
FIS	Flight Information Services
FLOWSIM	Flow Simulation Model
FMA	Final Monitor Aid
FMS	Flight Management System
FRP	Federal Radionavigation Plan
FSM	Flight Schedule Monitor
FTMI	Flight Operations and Air Traffic Management Integration

G

GA	General Aviation
GDM	Ground Delay Manager
GPS	Global Positioning System

H

HARS	High Altitude Route System
HF	High Frequency
HIRF	High Intensity Radiated Fields
HNM	Heliport Noise Model
HSCT	High–Speed Civil Transport
HSI	Human Systems Integration
HUMS	Health and Usage Monitoring Systems

I

ICAO	International Civil Aviation Organization
ICAP	Integrated Crashworthiness Analysis Program
ICTS	Icing Induced Tailplane Stalls
IDEA	Innovation Development and Engineering Applications
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions

INM	Integrated Noise Model
IOC	Initial Operating Capability
IR&D	Independent Research and Development
ITS	Intelligent Tutoring System
ITWS	Integrated Terminal Weather System

J

JFK	ICAO designator for John F. Kennedy International Airport
JSS	Job Satisfaction Survey
JTA	Job Task Analysis

K

KRASH	A software package for airframe structural analysis

L

LGA	ICAO designator for LaGuardia Airport
LIP	Limited Installation Program
Loran	Long–Range Navigation

M

Mode S	Mode Select Discrete Addressable Secondary Radar System with Data Link
MOPS	Minimum Operational Performance Standards
MWP	Meteorologist Weather Processor

N

NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASPAC	National Airspace System Performance Analysis Capability
NASSIM	NAS Simulation
NDI	Nondestructive Inspection
NOTAM	Notice to Airmen
NRP	National Route Program
NSC	National Simulation Capability
N–SDAT	National Airspace Sector Design Analysis Tool

O

OBIGGS	Onboard Inert Gas Generating System
OCC	Operations Control Center
ODAPS	Oceanic Display and Planning System
ODF	Oceanic Development Facility
ODID	Operational Display and Input Development
ODL	Oceanic Data Link
OPTIFLOW	Optimized Flow Planning Tool
OT&E	Operational Test and Evaluation
OTFP	Operational Traffic Flow Planning
OTPS	Oceanic Traffic Planning System

P

PC	Personal computer
PLV	Powered–lift Vehicle
PRM	Precision Runway Monitor

R

R,E&D	Research, Engineering and Development
RFP	Request for Proposal
RNP	Required Navigation Performance
RTCA	Radio Technical Commission for Aeronautics

S

SARP's	Standards and Recommended Practices
SATCOM	Satellite Communications
SATORI	Situational Assessment Through Operational Replay of Incidents
SBIR	Small Business Innovation Research
SDAT	Sector Design Analysis Tool
SE	Strategy Evaluation
SFA	Survey Feedback Action
SIMMOD	A trademark name for the FAA's Airport and Airspace Simulation Model
SMARTFLO	Knowledge–based Flow Planning Tool
SPAS	Safety Performance Analysis System
SPEARS	Screener Proficiency Evaluation And Reporting System

T

TATCA	Terminal ATC Automation
TCAS	Traffic Alert and Collision Avoidance System
TCCC	Tower Control Computer Complex
TERPS	Terminal Instrument Procedures
TFM	Traffic Flow Management
TIDS	Tower Integrated Display System
TMA	Traffic Management Advisor
TMS	Traffic Management System
TMU	Traffic Management Unit
TRACON	Terminal Radar Approach Control
TRB	Transportation Research Board
T–SDAT	Terminal Airspace Sector Design Analysis Tool
TSO	Technical Standard Order

U

U.S.	United States
USWRP	United States Weather Research Program

V

VHF	Very High Frequency
VOR	VHF Omnidirectional Range

APPENDIX D

Alphabetical Index of R,E&D Projects

APPENDIX E

Project Changes Since The 1991 R,E&D Plan

Projects that have been completed, renamed, combined, or withdrawn since the 1991 R,E&D Plan publication are listed by chapters.

PROJECT NUMBER	PROJECT TITLE	LAST ACTIVITY
	Capacity and Air Traffic Management Technology	
021–110	Advanced Traffic Management System sections pertaining to Dynamic Ocean Track System (DOTS)	Combined With Project 021–140 1992
	Advanced Traffic Management System to Advanced Traffic Management System (ATMS)/Operational Traffic Flow Planning (OTFP)	Name Change 1995
021–140	Oceanic ATC Automation to Oceanic Air Traffic Automation	Name Change 1992
021–150	ATC Applications of Automatic Dependent Surveillance (ADS)	Combined With Project 021–140 1992
021–160	ATC Automation Bridge	Terminated in 1993
021–170	Advanced Automated En Route ATC (AERA) Concepts	Withdrawn in 1992
021–200	Surface Movement Safety and Guidance	Combined With Project 021–190 1992
021–210	Tower Interim Display System to Tower Integrated Display System	Name Change 1992
021–220	Airport Capacity Improvements to Multiple Runway Procedures Development	Name Change 1993
021–230	Wake–Vortex Avoidance/Advisory System to Wake–Vortex Separation Standards Reduction	Name Change 1992
	Wake–Vortex Separation Standards Reduction to Wake–Vortex Separation Standards	Name Change 1995

PROJECT NUMBER	PROJECT TITLE	LAST ACTIVITY
022–140	Vertical Flight Program to General Aviation and Vertial Flight Technology Program	Name Change 1995
025–110	National Simulation Laboratory (NSL) to National Simulation Capability (NSC)	Name Change 1992
025–120	Operational Traffic Flow Planning	Combined With Project 021–110 1995
025–140	System Performance and Investment Analysis	Moved From Appendix B 1995
026–120	Diagnostic Tools and Future Technology to Airway Facilities Diagnostic Tools and Future Technology	Name Change 1993 Combined With 026–110 1994
026–130	Functional Models and Evaluation Tools to Airway Facilities Functional Models and Evaluation Tools	Name Change 1993 Combined With 026–110 1994
	Communications, Navigation, and Surveillance	
033–120	Mode S Sensor Data Link Enhancement	Withdrawn in 1993
	Weather	
042–110	Integrated Airborne Windshear to Aeronautical Hazards Research	Name Change 1995
	Airport Technology	
051–140	Demonstrations and Concepts Evaluation	Terminated in 1993
	Aircraft Safety Technology	
062–110	Aircraft Crashworthiness/Structural Airworthiness to Advanced Materials/Structural Safety	Name Change 1995
064–110	Flight Safety/Atmospheric Hazards Research to Flight Safety/ Atmospheric Hazards	Name Change 1992

PROJECT NUMBER	PROJECT TITLE	LAST ACTIVITY
064–120	International Aircraft Operator Information System	Terminated in 1993
067–110	Fire Research	New Project 1995
	System Security Technology	
072–110	Weapons Detection	Combined with project 071–110 1994
073–110	Airport Security to NAS Security	Name Change 1994
074–110	Security Systems Integration	Combined with project 071–110 1994
	Human Factors and Aviation Medicine	
083–110	Airway Facilities Maintenance Human Factors to Airway Facilities Human Factors	Name Change 1992
087–110	Workforce Performance Optimization	New Project 1994
	Environment and Energy	